# Municipal and County Engineering

**DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS**

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# OBLIGATION OF STATE HIGHWAY DEPARTMENTS TO KEEP PUBLIC SOLD ON HIGHWAYS

*By H. E. Hilts, Acting State Highway Engineer of Pennsylvania, State House, Harrisburg, Pa.*

We know as road builders, we have something to sell; we know we have to sell it to someone, and we hope that we have some talking points to help us in disposing of it.

A study of the history of transportation shows the necessity for leadership and vision, because people as a rule have been slow in availing themselves of new ideas and new modes of transport. New ideas in transport, like all other commodities, have to be sold. Our present day commercial transport is sold and we are all more or less conversant with the methods used by our shipping service, and our inter-and intra-state carriers in selling their particular facilities to their clients, both by publicity campaigns and paid agents.

*Still in Pioneer Stage*

In the field of highway transport, a new mode of common carriage has rapidly developed. It is still young and is still in its pioneer stage of development. It is a mode which if used and promoted conservatively will augment, simplify and make more economical and commercially more remunerative both water and railway transport. If, however, its powers are spent in endeavoring to usurp the functions of the other carriers, it would seem that our new mode of transport will be retarded in its development.

In the light of common prudence the agencies of the people, the State Highway Departments, should play their part in giving the public authoritative information on highway transport, as it involves the roadbed and right of way.

*Selling the Business Man*

Broadly speaking, the pay transport is that of the manufacturing and commercial interests, and classified directly these interests have to be sold on the ideas of—(1) "Selective" carriage by the motor truck on our highways in contra distinction to the common carriage of the railroad, and (2) in the use of the motor vehicle for short haul traffic. This "Selective" carriage is that part of commercial highway traffic that has or will prove cheaper in total cost to the consumer, and it will, therefore, automatically be adopted by industry in preference to other methods of haulage as is evidenced by the moving of furniture, or other selective commodities, long distances in the thickly settled east, and the use of motor trucks by milk, produce, and other interests for movements up to one hundred miles. In general, the commercial interests are exponents of the value of good roads, but there has been a marked laxity on the part of the State Highway Departments in giving out information which is live information, and the spasmodic attempts by personal address have not carried the message of economical use to these people. The commercial interests are appreciating that the highway engineering profession consider road building in the light of a business proposition, and that as in all commercial enterprises, the money which is invested in a good road represents tangible value in giving a more even and satisfactory roadbed, a route that has eliminated rise and fall or distance. They are beginning to appreciate that if bond issue money is used, that tangible value should exist at the expiration of the bond period, and further, that the earning power of the road, which begins the day it is open for traffic, should more than offset the money required for upkeep charges, depreciation and obsolescence.

*Highways as Feeders*

The railroads are the sponsors for the trite remark that highways should be built as feeders to the railroads. There have been few highways built in this country that have not been feeders to the railroad. From the nature of the case, it would seem the greatest feeders entering a given town are ones that carry the most traffic to and from the town and, therefore, our primary routes are the ones that should be first improved with modern thoroughfares. Many times this viewpoint does not seem to take into consideration the fact that automatically the semi-feeders, the secondary roads, are being constantly maintained and strengthened from current taxation, and that industry can accomplish much by strengthening the aims of the State Highway Department in its endeavor to have local road revenues spent to the best advantage. The road builder, the motor truck manufacturer, and the railroads have a common interest in selling the road user reasonable selective traffic, and the sale of the idea that a reasonable load should be carried within the legal limits of speed, and in a vehicle that meets all legal requirements. We must not lose sight of the fact that the real

birth of truck traffic was during stormy times, and that overloading and its attendant evils were thrust upon the highways before the remedies could be applied. It would seem that the general crystallization of ideas of all the interests involved is leading to a more conservative gross vehicular load and wheel load, and the research work which has been conducted by the Bureau of Public Roads, and several of the State Highway Departments is being practically interpreted to mean more conservation on the part of all interests in the general interest of the good roads movement.

*The Electric Railway*

In the case of the electric railway, we have to handle a different educational sale. The electric railway during its relatively short growth automatically found its level as a feeder or helper to the railroads. It searched out corners of our country which could not be reached economically, due to physical conditions, by the steam lines, and it has done much to raise the tone of the communities it serves. Generally, many of these lines have broadened their activities so as take in the power or lignting fields. Thus they have automatically become super-public-service corporations. The motor vehicle in its earlier day did in its unregulated field offer grave competition, as it noted in the jitney craze of ten years ago. It was quickly proven, however, that the widespread use of jitneys was economically unsound, and we now find the regulated motor vehicle used as a common carrier of passenger traffic. In the large centers of population, it has become the taxi, or motor bus, which is recognized as a selective carrier augmenting the electric lines, and it is regulated in its service by the Public Service Commissions, whether or not it competes with existing steam or electric lines. Automatically, this method of common carriage is being sold to the public by necessity, and in its turn it makes for the use of more and better highways. It is interesting to note that the widespread use of commercial bulk haulage by motor truck for long distances has yet to prove its economy.

*Highway Financing*

The largest class of road user, the owner of the pleasure motor vehicle has as yet to be sold the salient idea of highway financing. He does not yet realize that roads cost money, that definite road policies of construction, maintenance and administration are necessary. He does not realize that he has a vehicle that is dangerous to his fellow man when improperly used. The courtesy of the open road has not as yet made its appearance. If the road official does not take in hand and continually sell and resell the idea of road courtesy, he is leaving one of his greatest assets dormant. The selling of such stock phrases as "The man on your right has the right of way," the selling of ideas of correct lighting of motor vehicles, the courtesy of remaining on your own side of the road, the heeding of warning, danger and direction signs, the use of judgment in approaching grade crossings, all are tangible set ideas which all road users should be taught, and in being taught they gradually imbibe a more wholesome respect for the road and their fellow man.

It is interesting to note in this connection that gradually the owner of a motor loses his individualism. As his radius of travel increases he realizes that good roads do not mean just a road for his own locality, but that he must broaden his vision and his efforts so that his township, his county or his State are made accessible if he is to derive the full benefits of his new investment. We will always have the stay at homes who will never appreciate the growth and progress of the country as a whole and they, as in the past, will be the greatest opponents of highway progress, but even they are not hopeless as far as highway education is concerned. A few of the states have fostered the touring idea, not in the broad sense of the national automobile associations, but in the more homely and restricted sense of giving local news items for the smaller dailies and through channels of this kind must the stay at homes be reached.

*Correlating All State Agencies*

In all this educational work many look to the State Highway Departments alone. However, this is a restricted viewpoint. If we are to make surer and quicker progress, we must correlate all of the agencies of the state. The business man's viewpoint must govern and regulate the many activities of a state administration, the several departments of the state administration having much in similarity to the departments of an active, well managed business enterprise. In business the exchange of ideas between these departments is conducive to the success of the several departments and the enterprise as a whole. The problems of design, construction and maintenance, and the problems of economics of the

highway department are closely associated with the inter-department co-operation of the State Department of Agriculture, which is intimately associated with the needs for rural transportation. In the Eastern states the neglect of agriculture is the paramount cry of those interested in this phase of human endeavor; in the middle and far West the reverse is the case; but in either event, it has been one of the inconsistencies of American progress that the farmer's car has been allowed to remain in the mud. If more attention is given to the construction of good roads, towns will widen and stabilize their trading zones, and agriculture will again in the East, draw its people back to the farm, and thus place life on a more equable plane. The State Department of Education appreciates that hand in hand with its endeavors should go the endeavors and thoughts of the Highway Department, and yet how few and far between have been the spasmodic attempts at co-operation. The graded school can replace the old red school house only after good travelable roads have been built, because only then can every day travel be accomplished. Yet how seldom is this reflected in the co-operative educational efforts of these Departments. In turn we could discuss joint co-operation with State Departments of Commerce, of Internal Affairs, of Water Supply and Forestry, of Labor and Industry and of Public Service Commissions, and yet, how seldom is this co-operation actually sought by the departments in question.

*Highway Department Must Be Respected*

The obligation of the State Highway Department is not fulfilled merely by selling ideas, for before it can sell anything it has to, like any other business enterprise, have the healthy respect of the people for both its purposes, its judgment and its work. If the people are led to believe that its purposes are political, that its judgment is biased and its work is poorly handled and wastefully done, it can't sell ideas. Therefore, when the general policy of a live department is decided upon, after definite and long continued conferences with the people and with the interdepartmental divisions, let the people know—don't hide it. Expenditures are large, tens of millions of dollars yearly in many states, and the making available of funds in future years will be one of the jealous prerogatives of future Legislatures. State programs always will depend upon the Legislatures as representing the will of the people; therefore, public opinion should be courted. Much has been said of decentralized control as against centralized control. If the public are informed by impartial observers who know the work that the department is a real going concern, if they appreciate that there is a definite policy, close financial control, rigid construction standards, real teamwork in the organization, then they can appreciate that the selling arguments are sound. The concomitants that go with this definite appeal to the public, however, are sound engineering skill in maintenance and construction, and real business contract co-operation with the contractors who accept the state's business.

*Establishing a Policy*

Probably the most important single step that a department takes is the establishment of its policy. Many experts and laymen believe that policy represents the ideas of one man or a group of men. In some cases, this is probably true. It would seem, however, that a strong basic policy will stand only after it represents the consensus of opinion of the thinking people of the state. For instance, prior to beginning the program that has been carried out in Pennsylvania during the past four years, the late Commissioner Lewis S. Sadler, after wide publicity and hundreds of interviews with interested delegations, concluded that it was the idea of the people of the Commonwealth that assessed valuations and county lines be ignored in planning for the construction of the Pennsylvania primary highway system, that the viewpoint of the people was to construct a trunk line system connecting centers of population within the State and without the State by reasonable connections with the primary systems of adjacent States. The whole cost of the primary system was assumed by the State, the counties being urged to use their available funds in the construction within their limits, of the secondary system as constituting roads of local importance but not used by the public within the State as a whole. The secondary system could be built either in co-operation with the counties on a 50-50 basis, the State funds coming from Legislative appropriations, or by the county on a bond issue or current revenue program. As a further policy, which was given publicty in the press throughout the State, it has become generally known that the State is empowered by Legislative enactment to do the engineering work,

award contracts, and superintend construction on the request of any county, the county meeting only the cost of construction work. This enactment has sold to the majority of the counties, the services of an organization equipped to handle their construction work with economy, efficiency and dispatch under standardized State wide methods. Establishing a policy is only one step—it should thereafter be given wide publicity.

*Economics of the Road*

There are other policies that are as important as a broad general financial policy. One of these is that which deals with the economics of the road. In Pennsylvania, for instance, one of the great industrial States of our Country, we had prior to starting our program, just gone through the trying transportation difficulties of the War. The heavy use of our roads in augmenting the steady flow of war materials by rail brought out in a startling and definite form, the fact that our main trunk highways were not sufficiently strong to withstand the constant flow of supplies by motor truck from the midwest to the embarkation points on the seaboard. This experience is still fresh in our memories, and to my mind this period, from 1917 to 1919, will be considered as a turning point in our conception of the use to which our primary roads may be put in a time of stress, or a great national emergency. An analysis of this emergency by the public and the engineering organization developed the policy, which was given wide publicity in the press, of constructing primary roads of the so-called durable types in active competition, when the Engineering Division was satisfied that there would be real competition, the work being awarded to the low bidder, irrespective of type. This policy has been rigidly adhered to for the past four years. If a low bidder fails to qualify, his bid is rejected and the work is readvertised. Another policy, which has been given wide publicity in our State, is that if an improved road is needed, it, like any other commodity, has to be bought in the open market. It naturally follows that in a period of high or uncertain prices, large construction programs may needs be deferred, and only the most important construction links be given consideration.

*Influence of Engineering Standards*

It is not self evident that engineering standards of construction can help to sell the public the roads it needs. However, it is rather striking to find that delegations of laymen who visit headquarters will spend considerable time looking into standard bridge practice, look over specimens of road surfaces, and in every delegation there are a few men who appreciate that the present highway engineers are entering in a new field of endeavor; that they are not following out rule of thumb methods of guessing at this or that, but that slowly they are attempting to evolve logical engineering designs to fit the needs of the loads which are or may become legal, and therefore used. The bold designs of the past are being replaced by conservative standards which in the future will bear the light of increasing scrutiny. More and more as the light of truth creeps into the field of highway engineering, the failures of the past will be shown up in their true light as failures, not so much of engineering as of the system under which roads have been built; the system which on the one hand calls for extended mileages of secondary types, and on the other for short mileages of wide suburban thoroughfares. It is true that some engineers still live in the memories of the past; they think in terms of 1910. In 1910, Pennsylvania only registered as many motor vehicles as have been registered in a single day during a recent month.

*Correlating Construction with Maintenance*

Probably one of the most important field policies, and one on which the public must be not only sold by telling, but repeatedly sold by retelling, is that of correlating construction with maintenance. A workable theory is that maintenance means not only the maintenance in the densely populated states, of the old roads, but also the improvement by current revenues of the rural roads which are in a primary system, and which are not yet susceptible to the expenditure of bond monies for their improvement.

When the maintained main routes become increasingly burdensome year by year, not only on account of maintenance or other expenditures, but also on account of burdensome hindrance to economical vehicle or transport operation, then correlate these sections by durable construction. This correlation means a detailed study month by month, and year by year by the Maintenance and Construction Engineers; it means study not only in the field, but also in the office after yearly charges have been segregated. An annual program involving 500

miles of resurfacing year by year; surface treatment of 1,800 miles a year, and construction of durable types at the rate of 500 miles a year must need be correlated, so that economical expenditures be planned and made, and the details of a program of this character have to be sold to the public through the press, and by pointed constructive talks and lectures. The public must be made to realize that highway work is a great continuing business which cannot be tampered with.

*Attaining General Understanding*

This sale is not all accomplished by cold type and conservative oratory. The most convincing public official I have ever met, a man who had the keen insight of a financier, the logic of a successful business man, and who unknown to himself immediately gained the confidence of his constituents by personal conferences with legislative committees, with County Commissioners and representative citizens, did not look upon visitors at headquarters as pests or ingratiating individuals who called because they wanted something. To him they were the individual through which he could talk to hundreds, to him they appeared as the representatives of their districts, and he would spend hours in conference, enlarging upon viewpoint after viewpoint, and gradually drawing their interest closer and closer until there was mutual understanding. All executives cannot be of this type, because it is exhausting of both time and energy, but to a man who can draw an efficient, enthusiastic corps about him selling his constituents is his big side line.

The total yearly volume of sales of a State Highway Department to the people of a state is anywhere from $12,000,000 to $45,000,000 per state, striking an average of say $20,000,000. Can we gather any light by comparing this average department with an efficient corporation doing this gross business a year? Does the corporation spend money to make sales, does it spend money to create desire for goods, does it spend a conservative sum for research and for increasing the efficiency of both the employee and the plant, and when all is said and done are these sums conservative with the ends achieved? You will say yes. Analyze the Municipal, County or State Highway Department. Does it usually make any effort, not to spend money for publicity purposes, but to create desire for roads through channels that are opened freely to them, does it allow in its budget anything for research or refined design practice, or does it organize for efficient publicity work? Most of us will admit broadly—no. Still when the public asks as to taxes, indifferent service, poor maintenance, misinformation, inferior detours, unanswered construction complaints, and all the other miscellaneous complaints that buzz throughout the year, we find that they all can be summarized to come under the broad general publicity outline. The only conclusion that can be drawn is that we haven't still perceived the business man's viewpoint.

Enthusiasm must be created for our work, our job and the things yet to be accomplished, because in the end it is the spark of enthusiasm that sells or builds or creates great enterprises.

The foregoing matter is from the paper by Mr. Hilts before the recent annual meeting of the American Road Builders' Association.

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# FEATURES OF NEW WELL WATER SUPPLY AT MEMPHIS, TENN.

*By J. R. McClintock, of Fuller & McClintock, Consulting Engineers, Produce Exchange Bldg., Kansas City, Mo.*

An interesting well water development is now under construction for the city of Memphis, Tenn., as a result of a careful investigation of the city's water supply made during the latter part of 1921 by Fuller and McClintock, engineers. The new works will comprise a complete new pumping station, with covered equalizing reservoir, iron removal plant and aerating devices, supply mains to the distribution system and a new system of wells as a source of supply. This development is known collectively as the Parkway Station and will replace all of the present municipal supply and pumping facilities. The present population of the city is about 175,000.

*The Gathering Ground*

Memphis is fortunate in possessing underground strata which yield abundant quantities of soft, pure, cool water. These strata comprise sand layers, of varying degrees of fineness and of a total depth of several hundred feet, known as the LaGrange formation. This formation is overlaid at Memphis with 300 to 400 ft. of impervious clays but outcrops about 25 miles east of the city for a width of many miles, this outcrop furnishing the collect-

ing area. In earlier years a few artesian wells were secured in the LaGrange formation at low points but, in general, at the present time the hydrostatic level is 25 ft. or more below the ground surface.

The city has obtained its entire water supply from wells in this strata for some 30 years and there are a large number of private wells supplying hotels, industrial plants and other buildings. The average daily consumption of water from the municipal works is about 80 gals. per capita and an equal quantity is estimated to be obtained from other wells. The water is remarkably soft for a ground water and entirely free from contamination, where the wells are properly protected from surface leakage. In certain wells, however, appreciable amounts of iron are found which make the water objectionable for laundry purposes, and the well water generally contains about 110 parts per million of free carbonic acid rendering it exceptionally corrosive.

Serious consideration was given to a filtered supply from the Mississippi River before deciding upon a new well supply. While such a supply would be feasible, and with suitable purification works could be made reasonably satisfactory, the establishment of a safe and stable intake would be very difficult and expensive on account of the shifting character of the Mississippi River at Memphis. Careful estimates of cost indicated clearly that both the investment cost and the operating charges would be substantially higher for a filtered river supply than for a ground water supply.

### *Air Lift Pumping Adopted*

It was recognized that any method of pumping water in large quantities from deep wells was bound to be relatively inefficient. Careful comparisons were made of the advantages of electrically driven deep well pumps as compared with the air lift. With properly designed equipment and efficient machinery the total cost of raising water by means of the air lift was shown to be less than with electric driven well pumps, taking the overall efficiency from coal pile to water and making due allowance for probable maintenance and repair expenses.

The simplicity and reliability of the air lift, particularly the freedom from moving parts, requiring oiling and subject to wear, make it a more satisfactory method of pumping the wells than centrifugal deep well pumps with high speed runners and long shafts located at inaccessible places deep in the wells. Further advantages of the air lift are the flexibility with reference to variations in lift as well as the ability to deliver overloads. By varying the locations of the foot pieces and the quantity of air supplied it is readily possible to adjust to wide ranges in conditions as regards draw down and capacity, and yet maintain reasonably good efficiency.

The assumption of an overall efficiency of 25 per cent from the steam indicated horse-power of the compressor to water horse-power, which was used in comparing the air lift with deep well pumps is believed to be materially lower than can be readily secured in practice. At a number of places elsewhere, notably Madison, Wis., and St. Paul, Minn., air lift efficiencies of 35 to 40 per cent. have been secured in regular practice with suitable equipment and careful attention to the operation of the plant. At Memphis it is proposed to provide all necessary equipment and to design the plant so that the very highest efficiency may be maintained. To this end instruments will be provided at each well for measuring the flow of air and water and the air pressure at the well, and recording the water elevation in the well.

The air supply to each well will be regulated by valves or controllers in such a way as to prevent the excessive rush of air through a single well that might result from improper adjustments of the foot piece to the air pressure maintained, and from variations in draw down. Air lines of liberal size are to be used to minimize friction losses in delivering the air from the compressors to the wells. It is proposed to run a series of tests on each well and modify the submergence of the foot piece so that it will be closely adapted to the air pressure carried and the lift prevailing at that particular well. An economical average ratio of submergence for the entire group of wells will be selected so that they can all operate properly on practically the same air pressure. In general it is planned to provide sufficient wells so that they may operate with an economical draw down rather than attempt to secure a certain maximum capacity from each well.

### *Metering the Air Supply*

As a check on the total amount of air delivered to each of the four groups of wells a Thomas thermo-electric meter will be placed on each main air pipe at the Parkway Station. These meters will give accurate readings of the amount of air delivered under varying conditions of

pressure and temperature and will be used also in determining the delivery of the compressors during the duty tests.

Preliminary experiments are to be made on some of the existing Memphis wells to determine the merits of different types of air gauges, controllers, foot pieces and meters and particularly to develop the practicability of a more efficient type of eduction pipe. Owing to the necessarily high velocities in eduction pipes the friction losses are considerable in any case, and rapidly increase as the interior becomes corroded as occurs with steel or iron pipe. Due to the expansion of the air in the rising column of water the velocities at the upper end of an eduction pipe are higher than at the bottom unless the pipe is tapered or enlarged. A tapered eduction pipe is therefore to be tried, made up of lengths of copper tubing varying by about ⅛ in. in diameter, slightly flared at one end and brazed together. Although such an eduction pipe would cost considerably more than one of steel, it is believed, if it is mechanically feasible, that it will materially improve the efficiency of the air lift.

The air lift possesses a very important advantage at Memphis, as evidenced by numerous careful tests, in that it removes 80 per cent. of the free carbonic acid. For a thoroughly satisfactory supply the carbonic acid should be completely eliminated in order to furnish a water without corrosive properties. As a result of various experiments it was determined that the free carbonic acid remaining in the air lift water could be reduced to about 5 parts per million by means of an aerating device of suitable type. If desired this small residual quantity can be removed by the addition of a little lime.

*Aerating Equipment*

The aerating equipment found to be most advantageous consists of a series of four trays, each about 10 ins. deep, containing broken coke and superimposed one above the other with open spaces about 9 ins. between the trays. The trays will be built as a series of 40 units, each about 2 ft. wide by 7 ft. long with wide air spaces between to allow free circulation of air. With such an arrangement the water can be properly aerated at a rate of about 30 gals. per square foot of aerator per minute. Water will be distributed over the top trays by troughs with perforated copper bottoms. The aerating units will be built of concrete with bottoms of copper or brass wire mesh so as to avoid corrosion or decay of any portion of the structure.

*Iron Removal*

The iron in the Memphis well water can be readily removed after aeration by filtering through sand at rates commonly used for mechanical filters. A complete rapid sand filter plant is being built which will remove the iron and at the same time furnish protection against any accidental pollution of the well water on account of leaky well casings or from other causes. This plant will comprise eight filter units of 2.25 million gallons daily capacity each, with concrete tanks and wash water gutters and a strainer system of perforated, galvanized wrought iron pipe. Hydraulic gates and operating tables will be provided for controlling the filters as well as rate controllers and loss of head gauges. The filters will be washed by water from a concrete tank in the top of the head house at the so-called "high rate." In the head house ample space will be provided for laboratories, offices, toilet rooms and for storing lime, and duplicate dry feed machines installed for applying lime to the aerated water.

*The Wells*

The proposed system will comprise about 20 wells spaced about 500 ft. apart and located partly on private lots along a beautiful parkway in the north end of the city and partly along a strip of land which has been purchased by the Artesian Water Department for the purpose. There will also be four wells located on the new Parkway Station site. The wells will have 12 in. steel casings with 50 ft. of 10 in. brass, well strainer of the Cook type and at the top will be provided with an additional 18 in. casing. It is expected to secure a yield of about one million gallons daily from each well with a draw down of about 25 ft. The estimated average pumping lift from the wells to the surface is about 75 feet.

The well houses will be designed so that a portable steel derrick can be mounted on the roof in case it should be necessary at any time to reset the well strainers or withdraw the casings. Drains will also be provided at each well to remove any waste water which may result from cleaning out the well.

*Structures*

The entire development is being constructed in a first-class, substantial manner throughout. Both the Parkway Station and the wells are located in a high class residential district and every effort will be made to make all structures at-

tractive and pleasing to the adjoining property owners. The pumping station and the superstructures of the iron removal plant and aerator will be constructed of high grade, tapestry brick with Bedford stone trimmings. The main floor of the pumping station and iron removal plant will be floored with red quarry tile and the interior walls are to be lined with light grey semi-glazed brick. All structures will be entirely fireproof throughout. The storage reservoir will be covered with 2 ft. of earth and sodded, and it is proposed to construct six tennis courts on top of it. Each well head is to be housed in a neat, tasteful little building of tapestry brick and cut stone and the entire lot on which the well is located neatly graded and planted with grass and shrubs. Likewise the entire Parkway Station site will be attractively parked.

*Capacities*

The average daily capacity of the entire plant is about 18 million gallons, but the wells, aerator and iron removal plant are designed to carry temporary overloads of 50 per cent. to take care of maximum periods of consumption. The storage and equalizing reservoir will have a capacity of 10 million gallons which will be ample to supply any probable fire draft and provide for daily peak rates of consumption. The high lift pumps will comprise two horizontal crank and flywheel units and two turbine centrifugal pumping units, each with a net capacity of 15 million gallons daily. There will be four cross compound air compressors, each with a capacity of 2,700 cu. ft. of free air per minute. It is expected that this Parkway development for a period of 8 or 10 years will furnish the water supply of the entire city and that it will permanently provide for the western section of the city, including the main business and industrial district. In the course of a few years, however, it will be necessary to construct a second station to take care of the rapidly growing eastern portion of the city.

*Station Details*

In planning the pumping station careful study has been given to arranging all equipment and piping so that the failure of any single portion will not impair the capacity of the plant to supply maximum demands. A complete header system has been provided for the high service pump discharge lines, with an elaborate arrangement of valves and cross connections to guard against any possible break that might occur. This same principle has been followed with all the auxiliaries and steam and other piping about the station. In order to concentrate the machinery to facilitate convenient operation, the four air compressors and four high lift pumping units have been placed in a double row with their steam ends along a central aisle. This has necessitated a clear span of 120 ft. for the roof of the pump room which is 160 ft. long.

A complete system of gauges and measuring devices is being installed throughout. Venturi meters are provided on the discharge lines of each high service pump and also on the raw water line to the aerator. Full sets of gauges are to be provided for all pumping units, air compressors, boilers and auxiliary machinery. The boilers will be equipped with automatic furnace control systems, Bailey boiler meters and CO-2 recorders. The hydraulic valves of the header system will be controlled from an operating table in the pump room.

*Centrifugal Pumps and Turbine Water Wheels*

The water from the wells will be delivered by a gravity conduit to the equalizing basin of about one million gallons capacity. In order to deliver the well water to the top of the aerator it will be necessary to lift it about 26 ft. This will be done by means of centrifugal pumps operated by small turbine water wheels which will be driven by pressure water taken from the discharge of the high lift pumps. After considerable study it was determined that this method of pumping would be cheaper than using small turbines or electric motors for driving the pumps, owing to the low steam consumption of the high lift pumps and the comparatively good efficiency of small water turbines.

*Boiler Plant*

The boiler plant will comprise four 350 horse-power units of the horizontally inclined water tube type designed for 225 lbs. operating steam pressure. Each boiler will be set separately and equipped with an underfeed stoker. Draft will be provided by a 9 ft. by 225 ft. radial brick chimney as well as by an electric driven fan for each stoker. The boilers will be equipped with superheaters, two units being designed for 75 degs. and two for 200 degs. so that the advantage of different degrees of superheat may be tried out in practice. The boilers, stokers and appurtenances have been planned to operate efficiently under wide variations of load to avoid the waste of banked fires as far as possible in operating the station at differ-

ent capacities. Modern coal and ash handling equipment is to be installed with a 500-ton suspended steel coal bunker above the firing aisle.

*A Great Well Water Development*

The new Memphis plant will be one of the largest municipal well water supplies in the United States and in many respects the most completely equipped. The total cost of the works will be about $2,500,000, including the main supply lines from the new pumping station to different points in the distribution system. The works have been designed by Fuller and McClintock, engineers, and Mr. F. G. Cunningham is resident supervising engineer for them in directing the construction. The architects for the superstructures are Messrs. Jones and Furbringer of Memphis. The entire project is being carried out by the Memphis Artesian Water Department, Messrs. F. G. Proutt, chairman; Milton J. Anderson, vice-chairman, and Thomas F. Stratton, commissioner. Mayor J. Rowlett Paine has shown the keenest interest in pushing forward this much needed betterment for the city of Memphis.

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# THE CORROSION OF UNDERGROUND STRUCTURES

*By E. R. Shepard, Consulting Electrical Engineer; 1620 Edison Bldg., Chicago, Ill.*

*Corrosive Action of Soils*

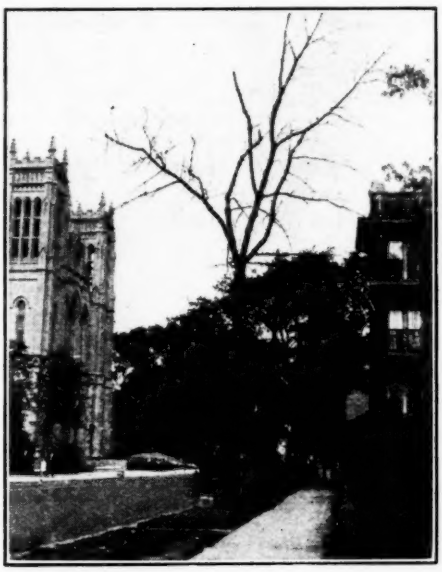
Underground piping systems are often considered as practically indestructible and when once installed as requiring no further attention or replacement. As a matter of fact they are always subject to deterioration and, under certain conditions, to very rapid and serious destruction. The chief causes for the rapid corrosion of pipes are to be found in: (1) Naturally corrosive soils; (2) Filled ground containing cinders, ashes or other foreign matter; (3) Electrolysis brought about by the action of stray electric currents, usually from trolley lines.

Among the corrosive soils should be mentioned those containing organic acids, which are formed by the process of vegetable decay. Such soils include muck and peat and are found in the alluvial deposits of the Mississippi River and in other swampy areas. Some kinds of alkaline and so-called alkaline soils occurring in the western states and in some portions of British Columbia and Manitoba are also destructive of iron and lead pipes. Salt marshes are not only corrosive to a certain degree but accelerate stray current electrolysis because of the low electrical resistance of the earth. The same may also be said of wet, black soil containing considerable organic matter, as these are usually found to have a low electrical resistance.

Cinders, ashes and filled ground containing refuse often produce extremely acute and rapid corrosion of piping systems. This corrosion may be electrolytic in nature, resulting from galvanic action between the metal pipes and the cinders or other foreign matter. Because of this it is difficult and often impossible to dstinguish between corrosion of this character and that produced by stray currents.

*Difference Between Soil Action and Electrolysis*

Even now after years of research and investigation there remains a great deal of uncertainty regarding the causes of pipe corrosion in many instances. Corrosion is often attributed to stray current action where the soil itself is a partial, if not the sole, source of destruction. Since chemical action is primarily an electrolytic phenomena, it is not possible to distinguish between such action and that caused by stray currents. Stray current action is often more rapid than natural rust or soil corrosion, and in the absence of sufficient oxygen, may produce the black or magnetic oxide of iron instead of the red oxide commonly known as rust. This is really the only difference



VIEW OF TREE KILLED BY GAS LEAKING FROM CORRODED PIPES

in the appearance of corroded pipes by which stray current electrolysis can be distinguished from ordinary soil corrosion, and even this test is far from reliable.

Circumstantial or contributory evidence is often to be found in the location on the pipe where the destruction takes place. Water and gas pipes and particularly service pipes often show local corrosion under street car tracks, or at points of intersection with telephone, or electric light cables or other lead sheathed cables which are electrically drained to the railway negative bus and are, therefore, lower in potential than the piping systems. Where highly localized or concentrated damage is found at such intersections, the evidence is pretty conclusive that it has been caused by a discharge of stray current to the other metal structure. Where the corrosion is general and no other structure is nearby, there is always a question as to the cause of the damage even though the pipes may be positive to a car track on the same street. As a rule electrolytic corrosion of pipes is not serious except at intersections with, or close approach to, electric railway tracks or other underground structures.

The fact that gas and water services of wrought iron and steel may have shown a more rapid rate of deterioration during recent years than prior to the installation of electric railways does not necessarily throw the responsibility for such damages on the railways. The manufacturing processes by which steel and wrought iron pipes are made have undergone such changes as materially affect their composition and structure, and it is a well known fact that modern materials are much more subject to corrosion than those produced by the older methods. This condition alone is no doubt responsible for the short life that is experienced by pipes in many localities.

*Experiments by the National Bureau of Standards*

A knowledge of the effects of different kinds of soil on the corrosion of buried metal structures was considered of so much importance that a year ago the American Committee on Electrolysis, in cooperation with the National Bureau of Standards, and a number of pipe manufacturers,instituted a comprehensive and nation-wide investigation of the subject. Thousands of small samples of different kinds of pipe were prepared by the manufacturers, and these have been buried in about 40 locations widely distributed throughout the entire country. All kinds of soil and climatic conditions have been included in the tests. Several samples of each kind of pipe are included in each set which will permit of unearthing them progressively over a period of years. Every sample was carefully weighed and the loss of weight resulting from soil corrosion can, therefore, be determined in an accurate and scientific manner. It is expected that positive results will be obtained in a period of two or three years and more definite results will develop as time elapses. These tests will be independent of any stray current action and are designed solely to determine the effects of different soils on different kinds of pipe, including lead, cast iron, steel, wrought iron, as well as some special materials. The whole investigation is being carried out in the most thorough manner by the Bureau of Standards and is being watched with great interest by the manufacturers and users of pipe.

The results of these experiments should be helpful in determining to what extent stray currents are responsible for the large amount of corrosion, particularly on steel and wrought iron pipes, that is in progress in most of our cities.

*The Earth Current Meter a New Instrument*

Another important development which is enabling engineers to differentiate more clearly between stray current electrolysis and soil corrosion is the earth current meter which has only recently been perfected by the Bureau of Standards. Instead of measuring the potential difference between pipes and adjacent car-tracks, which is not a reliable criterion of the hazard to which the pipes are exposed, the earth current meter measures directly the density of current discharge from the pipe surface to the earth. This instrument is now available, and where the necessary time and effort is given to its application, results can be secured, the validity of which cannot be questioned.

*Damaged Pipes Still in Service*

Pipes are often badly damaged if not totally destroyed long before actual failure takes place. This is particularly true of cast iron mains and low pressure gas services. When cast iron is corroded by stray currents there is left intact a residue of carbon and iron oxide which is strong enough to withstand gas pressure and even water pressure. It is not an uncommon practice in some cities to remove water mains which have been so badly damaged by electrolysis that holes

can be cut through them with a pocket knife. This is obviously a dangerous condition as failure is most likely to occur during a fire when the pressure has been increased. Cast iron gas mains are seldom replaced on account of corrosion as they remain gas tight even after the iron has been largely removed. It is also remarkable to what extent wrought iron and steel services can be damaged and still remain substantially gas-tight. This is particularly true in dense clay soil. It is true, of course, that leaks may occur as soon as the wall of the pipe is punctured, but on the other hand, service is often maintained with little or no leakage of gas through services that are almost totally destroyed.

This condition introduces another difficult factor in the problem of ascertaining the cause of corrosion. Pipes are often uncovered or removed which show severe corrosion, and the question always arises as to whether the electrical conditions which prevail at the time of the examination are responsible for the damage or whether some previous and unknown condition associated with the operation of the electric railway or the bonding of the tracks was the cause.

Corroded pipes are always a source of danger and many fires and explosions have been traced to leaks resulting from such conditions. Leaks from gas pipes may manifest themselves by the odor of gas in buildings or streets or by dead grass or trees. Escaping gas dries out the earth, thus destroying vegetation and in some cases it may also have a toxic effect. Escaping gas often finds its way into street conduits, vaults and buildings where it may be ignited with serious consequences. This happens most often in winter when leakage cannot take place through the frozen earth crust.

*Electrolysis Prevention*

Space does not permit of going extensively into the various methods of eliminating or improving electrolysis conditions, but a brief discussion of a few of the accepted methods of mitigation may be helpful to those who are not familiar with this phase of engineering.

Pipe coverings in the nature of dips or wrappings have not proved to be effective in preventing stray current action for any considerable period of time, although such protective coatings are of distinct benefit where soil action is the principal source of damage. Insulating joints in mains are often used to good advantage, but their locations should be selected by a competent engineer with full knowledge of the pipe network and the electric railway circuit. Insulating joints in individual services have not been extensively used, perhaps because no satisfactory inexpensive joint has yet been developed. Great possibilities for protection lie in insulating individual services which cross under street railway tracks, as this is the most frequent source of damage. In order to be effective the service must be insulated both at the main and at the meter to insure against current entering by way of gas water heaters.

Some companies have made a practice of laying two mains on streets occupied by car lines where electrolysis conditions have proved to be very bad. This practice enables them to run short services to their customers without approaching the car-track, and where this is possible little or no trouble has been experienced. It is not possible here to take up the merits and demerits of electrical drainage of pipes as a means of electrolysis mitigation. The practice is taboo with a number of gas companies because of their aversion to inducing currents to flow over their mains and making them a part of the return circuit of the electric railway system, with possibility of fires and explosions that may result from such currents. On the other hand, many gas and water companies have protected their system by the use of electrical drainage.

None of these methods enumerated really strike at the seat of the electrolysis problem which is primarily one for the electric railways to take care of. While it is not possible completely to insulate their rails from the earth and thereby prevent the escape of current to the earth, it is possible by good bonding and a sufficient number of substations and return feeders so to reduce the voltage drop on the tracks as to eliminate, in a large measure, stray currents from the earth and underground structures. The matter of electrolysis prevention is now being given more attention by the railway companies than it was in the past, and although in many places serious damage is still in progress, it is by no means as prevalent as it was in the early days of electric railways. There is also a growing spirit of cooperation between the railway companies and other utilities which enables them to handle this problem jointly and to the best interests of the public. Local electrolysis committees have been organized in a number of cities which represent the best practice at this time in electrolysis prevention.

# HIGHWAY BRIDGE CONDITIONS IN MASSACHUSETTS

*By William F. Williams, Commissioner Massachusetts Department of Public Works, State House, Boston, Mass.*

Of the many interesting problems before the Department of Public Works of the Commonwealth of Massachusetts, perhaps no one of them involves the elements of safety to life and property more than the highway bridges of the state. For about two years a bridge survey has been carried on largely by mail through the Selectmen of towns and engineering departments of the cities, although Boston and larger cities have been omitted for the time being.

The survey has also been confined to bridges 20 ft. or over in length, notwithstanding the department draws the line at 8 ft. and anything of a shorter span is classified as a culvert; but the Federal Government limits its assistance to bridges over 20 ft. in length. The principal reason, however, for eliminating bridges under 20 ft. in length was to get a quicker inventory of the more important structures whose repair or replacement to meet the conditions of modern traffic would require special consideration structurally and financially.

It should also be stated at this time that most of these bridges are owned and maintained by the town or county in which they are situated, although the character of the traffic is largely determined by the condition of the highways built and maintained by the state.

The present inquiry is also limited to securing only a general description of the bridges covering location, dimensions, age and present condition, and from the returns so far received we find there are, outside of the large cities, over 500 wooden bridges and about 450 iron or steel bridges that must be extensively rebuilt or replaced by new structures within varying periods of time, but not exceeding 20 years.

From this brief statement, you will realize the size and gravity of the bridge problem that confronts the towns and the Commonwealth, and the necessity for the adoption of a policy that is safe and economically workable.

In arriving at the probable strength of these bridges, it is reasonable to assume that the wooden bridges were built by rule of thumb, and the stresses were not actually calculated. It is evident, however, that the iron bridges were carefully designed to meet the load requirements of their period.

It is also an interesting development of the survey that many of the old bridges, both wood and iron, are much stronger than they are popularly supposed to be. If it were not for this fact, the Commonwealth would be confronted with an appalling financial problem.

There appears to be a general tendency to forget the original factor of safety in casually considering the strength of an old bridge. The average person is also more or less affected by the looks of the structure and especially by the noise caused by loose planks and the rattle of counter rods in iron trusses, especially in the pony type. It is too true that very few iron or steel bridges are kept properly painted. In some cases the neglect is so apparent and the results so serious that it is difficult to understand how the officials in charge escape public censure. Our investigations have also shown that the metal work of the old wrought-iron bridges is in remarkably good physical condition and even the more modern steel bridges, that are not near salt water, have not suffered as much from corrosion as might be expected from a casual view. It is all too apparent, however, that steel bridges are seldom kept properly painted. Generally they are left until corrosion has progressed so far that the entire metal surface has to be sand blasted or scraped and every vestige of the old paint removed, then they are painted two or three coats of paint and forgotten for another period of five or ten years.

The examination of many truss bridges in all parts of the state has shown that with few exceptions the floor joists or stringers are weak, but the trusses are generally strong enough for the maximum load that can use a public highway without a special permit. This is probably due to the fact that engineers for a number of years have used a live load of 75 to 100 lbs. per sq. ft. of floor and sidewalks for computing truss stresses which are the loads still used, but the assummed moving load was very much lighter than the maximum loads of today.

We have found wooden floors carried on light 6-in. eye beams where the panel length was 16 ft. Of course such a floor is very elastic and there is a great deal of vibration when a load is passing over it. It was also customary to use a few wooden joists of the same depth as the eye beams for spiking the floor plank to, in place of spiking them to wooden pieces bolted

to the upper flange of the eye beams. In fact, that is still a common practice, although it is a very poor method as the wooden beams deflect more than the steel beams and cause the latter to act as a pry which loosens the spikes in the plank.

In many cases by the substitution of heavier stringers and a new floor, excessive vibration is eliminated and a new lease of life for the structure is secured at a comparatively small cost. Of course the dead load is increased but this is more than offset by the elimination of impact stresses which in the case of heavily loaded motor trucks is a very serious menace to the structure.

Another rather dangerous feature of most of the old bridges is the lack of wheel guards that offer any substantial resistance to a collision with the truss members. This danger is accentuated by the narrow roadway, which is seldom more than sufficient for two trucks to pass with careful steering, and also by sharp curves in the approaches which is so common a feature of those old bridges which for reasons of economy were nearly always built at a right angle to the stream.

While all modern bridges are designed to carry safely a definite maximum moving load, Massachusetts has no legal standard load for highway bridges; but a highway bridge carrying a street railway must receive the approval of the Department of Public Utilities, which has adopted certain rules and standards that are used generally by engineers in this state when designing both highway and railway bridges.

For suburban or heavy country highway bridges: For the floor and its supports, a uniform load of 100 lbs. per sq. ft., or a 20-ton auto truck having 6 tons on one axle and 14 tons on the other axle, the axles being 12 ft. apart and the distance between wheels 6 ft. This truck is assumed to occupy a floor space 32 ft. in length and 10 ft. in breadth. For trusses or girders, 80 lbs. per sq. ft. of floor surface for spans of 100 ft. or less, and 60 lbs. for spans of 200 ft. or more, with proportional allowance for intermediate spans.

Under the Massachusetts law, 14 tons is the maximum weight of vehicle and load that can use a public way without a written permit from the authorities in charge of the way. This law says nothing about bridges, but it is assumed that a bridge is a part of the road on which it is situated and is, therefore, included within the term "public way."

Other provisions of law, however, have apparently relieved a county, city or town, from any liability for damages resulting from loads that exceed 6 tons, including the weight of the vehicle.

The law also provides that notices may be posted on bridges stating the maximum weight of vehicle with load which the structure will safely carry. In the case of bridges on any earth, sand or gravel road, this maximum weight of vehicle with load is specifically fixed as 6 tons.

The difficulty with these laws in practice is that the notice rarely ever states the actual safe load, as in almost all cases the bridge will carry much heavier loads than that named in the notice.

The notice should state the actual maximum load the bridge can safely carry as determined from an inspection by a competent engineer, and any damage to the structure resulting from its use by a load heavier than that stated in the notice, should be recoverable in an action at law from the owner of the vehicle that causes the damage.

In this way many of the old bridges can be utilized safely and without serious inconvenience to traffic, until they can be rebuilt or replaced by modern structures, and excessive financial burdens will not be placed upon the county, city, town or state.

In other words, the equity in existing bridges should be utilized as far as it is consistent with safety, and a sound economic policy of replacement.

At present, the state is building only reinforced concrete bridges of the beam and slab type for spans up to 40 ft. in the clear, and the arch for spans over that length. The roadway is 26 ft. wide in the clear between wheel guards, and the fences are reinforced concrete of the post and panel type. The country bridges do not have sidewalks.

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## TILE DRAINAGE OF HIGHWAYS IN IOWA

*By J. L. Parsons, County Engineer, Ft. Dodge, Iowa*

That the drainage of roads is a fundamental requirement is generally recognized and needs no discussion. In general the policy of draining all graded roads, both county and primary, with lines of tile constructed on both sides of

the roadbed is the rule in the State of Iowa. In my territory, where land drainage has proven so beneficial, the complete drainage of roads as rapidly as possible is the one item of construction that has not been criticized.

In my opinion these two lines of tile should be constructed the entire length of a road that is being prepared for gravel or pavement surfacing, over the knoll as well as through the low places. If a sufficient number of inlets are constructed the passage of surface water in road ditches, or the formation of small ponds caused by obstructions, is largely prevented and the resulting saturation of the grade is reduced to a minimum.

The efficiency of this form of tile drainage is measured by soil stability and depends upon the physical composition of the soils in the roadbed. For convenience reference will be made to three classes of roadbed soils; sandy, surface and clay or close-grained soils. In the first case there is no question of the rapid movement of all excess soil waters laterally to the tile lines. This will prove true even though there is present only a small percentage of sand or gravel. In the second case where the top soil has not been removed in the construction of the grade, and where the material added in grading operations consists of top loam, drainage is generally facilitated by the numerous watercourses formed in the soil by plant growth and percolating water. It is in the third case that the danger signal is sounded. Difficulty arises because of the greater capillarity of the close grained soils. Such soils will draw water for distances as great as 8 ft. and often hold in excess of 50 per cent of water by weight. In many cases tile lines constructed in the side ditches will benefit these soils very little because of water bearing strata extending laterally or longtitudinally below or between the tile lines from which the sub-grade becomes saturated by capillarity. Once the sub-grade becomes saturated, whether by the retention of water on the surface or by capillarity, the road surface will soon pound to pieces under heavy travel. Sub-grades of this character may give little trouble during the warmer seasons and become quagmires during the spring thaws. Apparently this is a result of the expansion of the saturated soil during freezing and its consequent contraction when thawing out.

In Webster County in the spring of 1922 we experienced considerable difficulty with bottomless roads. In all cases excepting one the breaks occurred in cuts, where the top soils had been removed, and all of them on roads recently graded. Also in most cases tile lines had been constructed on both sides of the road. In an attempt to keep all lines of travel open on the main roads different expedients were tried. We had little success with gravel, but in several cases we were able to bridge the breaks by applying heavy coatings of cinders. One aggravated break was temporarily bridged by two lines of bridge plank. In several cases we employed adjacent farmers to pull unfortunates out of the mud until a remedy could be devised, the bills to be paid by the county. The most effective results were achieved by lateral tiling where outlets were available. Two emergency gangs were organized as soon as the frost could be broken by the use of picks and lateral tile lines constructed across the affected areas at approximately 20 ft. intervals. The tile were constructed at depths of 2 to 3 ft. The beneficial results were immediate and pronounced in all cases where this work was done. The permanent effectiveness of this method can be determined only after a more extended experience. My opinion is that in some cases it will be necessary to fill the tile trenches with gravel or cinders and to construct tile lines at still closer intervals.

The foregoing paper by Mr. Parsons was presented at the recent annual meeting of the Iowa Engineering Society.

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## WATER INFILTRATION IN SEWER SYSTEMS

*By H. V. Pedersen, State Scnitary Engineer, Des Moines, Iowa*

Excessive infiltration in Iowa sewer systems has given rise to certain problems for which few engineers have really taken time for working out a satisfactory solution. In years past it has been easy to say, "build the sewer lines tight so as to exclude all water or put in underdrains," but these theoretical proposals do not always prove practical. Those that have not given the matter much thought may wonder why there should be problems, but those towns of the State that have been compelled to install sewage treatment plants to dispose of their sewage properly and those engineers of the State who have had opportunities to visit and study various plants should not have a particle of doubt as to the troubles caused by excessive infiltration.

Out of the total number of 190 municipal sewage treatment plants in the State 122 are equipped with the shallow, Cameron type of tank. Many of these tanks are of just sufficient size to take care of the needs of the town. There are some exceptions where the plants are much too small and some where the tanks will be plenty large enough for years to come, but the great majority of Iowa plants are laboring, even in normal times, under the heavy load forced upon them. Every time it rains, and more especially in the spring, the water that finds its way into the sewer system through infiltration is excessive for the good operation of the plant and the tank tends to unload its contents out onto the filters where it causes ponding by reason of the surface mat.

*Causes of Infiltration*

This excessive infiltration may be due to several causes. (1) The contractor or plumber to whom the duty of construction has been given may fail to lay the pipe on a proper bed or cement the joints as specified by the engineer. (2) The contractor may do the work entirely according to specifications but the engineer has failed to judge the conditions of the various stratas and to provide for suitable construction. (3) It may be that at places all the precaution of both the contractor and engineer are of no avail and excess water finds its way through seemingly watertight joints into the sewer.

There is little excuse for the first cause. The contractor should be made to understand that if he did not make the sewer joints as tight as he could, or provide a safe foundation for the pipe he would not be paid for his work. Too many times have contractors gone along with construction, allowing their men to do inferior work and then make a big bluff at the end of the job. Men trained to lay pipe often are of such intelligence that they do not realize the troubles caused by infiltration and do not take pains and, in some cases, actually try to slip one over on the inspector. It is known that some men take great delight in cheating, just to boast about it later.

Then, too, keen competition in bidding often makes it impossible for the contractor to do good work and break even. Naturally a contractor wants to make money on the job. The town awards the job to the lowest bidder, makes the contractor slice and cut his bid in order to get the job and then expects first-class work. Competition is a good thing but all towns and all engineers must realize that a sewer job should be let at such a price as to allow the contractor to do first-class work and make a profit. If the engineer would see that a contractor gets a good price and then demands the very best job possible it is the opinion of the writer that 75% of the troubles of infiltration would be overcome at the start.

The second cause is often more difficult to determine and may, in a way, be more excusable. It is not possible to test every foot of a proposed sewer system and an engineer can only base his conclusions and draw up his specifications on what he knows. But even if a set of specifications may be protected by a suitable foundation clause it is often the fault of good judgment whether or not a certain grade of sand makes a good foundation. In a suburb of a certain city in Iowa a sewer system was recently constructed. The geological formation was such that a great deal of fine running sand was encountered. The contractor had bid a straight price on natural foundation and so much extra for every foot of made foundation. In order to save the city as much expense as possible the engineer in charge gave orders, in many cases, not to protect the pipe by laying it on a good prepared foundation, but to take a chance on the supposedly good natural sand foundation. At the final inspection it was learned that the pipe in many places contained much sand and water and upon investigation it was discovered that the pipe had settled to such an extent as to cause the joints to open enough to allow the fine sand to wash in.

There are very few places in Iowa where the ground is entirely free from sand veins and most of these sand veins contain great quantities of water. It is not practical to put in under-drains to take care of one or two sandy places and oftentimes it only takes one sand pocket to yield enough water to cause troubles at the sewage treatment plant. These special places are left entirely to the engineer in charge to overcome. A suitable foundation should be determined upon and special care should be taken to secure tight joints regardless of the rest of the system.

We now come to the third cause, which cause is the hardest to understand and overcome. It seems on first thought highly improbable that if both contractor and engineer take all the necessary precautions known that the sewer will still leak, but it is a sure fact. A sewer was

being laid up a rather steep hill in a certain sewer system in Iowa. The ground was a hard yellow clay with an occasional stone. As the trenching machine was just rounding the top of the hill it struck a sand vein and without a single moment's notice, the water began to wash in sand and dirt and before the men in the trench could act they were standing knee deep in water. It took a week to lay the pipe a distance of 20 ft. through this vein. The trench machine had to be abandoned and hand work adopted. Everything a man could think of was done to lay the tile to exclude the water, but upon final inspection it was learned that the pipe on this hill flowed one-fourth full of water in spite of all the precautions. The whole secret was that the water from the sand vein began to follow the pipe and although the joints were watertight at the sandy place it seeped through the crevices far below where less precaution had been taken to secure tight joints. In this case no one could blame the contractor and no one could blame the engineer. It was one of those places we too often forget to take into consideration when designing a sewage treatment plant to take care of excess infiltration.

There may be other reasons why water finds its way into a sewer. It is not my intention to point out all the various possibilities, my idea is to point out and to prove that although it is possible to control the amount of infiltration by good design and good construction, to a certain extent, it is not possible, under our present day methods of sewer construction, to exclude water entirely, if there is any water in the ground to get in.

Almost every engineer will admit that most sewer systems leak. The Iowa State Board of Health, through its rules and regulations, admits that most sewers will leak when it specifies that a system where the infiltration is not more than 1.6 gals. per linear foot per day for the entire system is considered good construction.

The theory is generally advanced that if a new sewer system leaks more than 1.6 gals. per foot at the final inspection, it will tend to tighten up as it grows older. This may be true and it may not. No doubt there is a tendency for some joints to fill with dirt and sand and some water is excluded, but there is very little proof that this is as great as we like to think. From the great amount of infiltration that has been observed in a number of old sewer systems in Iowa, during time of rain, it is the opinion of the writer that if a sewer leaks when it is first laid, it will always leak.

Too little attention is given to securing watertight joints, even today. Every once in a while some better informed citizen of a community rises up in indignation and makes life miserable for an engineer or contractor, but somehow or other everything quiets down after a little. Everyone seems to argue, "well, what difference does it make if a little extra water does get into the sewer? The sewer is large enough and can take care of it." I will admit that a little extra water from infiltration in a sewer which discharges directly into a stream does no particular harm, but I do say that extra water from infiltration in sewers where the sewage is treated does have many bad effects. Take for instance, in the spring of the year after a tank has gone all winter without cleaning. As long as it is cold no one wants to clean it out and it is neglected as long as possible. All of a sudden a warm day melts the snow or a heavy rain sets in which penetrates the ground and finds its way into a sewer. Now when most of our shallow septic tanks become full of sludge the detention period becomes less and less and in many cases even the slightest amount of extra water tends to create currents within them. These currents stir up the light sludge like particles which rise to the surface and pass on out to the filters where in less than a day's time it has rendered the filters incapable of filtration. When we stop to consider the great number of plants in Iowa that are actually put out of commission every year and require a big expenditure of money to put them in shape, isn't it worth while for us all to consider a few possible ways of overcoming the trouble?

There has been some talk of using cast iron pipe for sewer construction. This method would certainly reduce infiltration but whether or not the extra cost of construction would be worth the having less trouble at the treatment plant is a question I am not ready to discuss. It is certain that in some sandy places it would be well worth the engineer's time to consider whether or not the use of cast iron pipe would be cheapest in the long run.

Some use has recently been made of compounds in place of cement for filling joints. The first experiments of these did not prove very satisfactory, but the compounds on the market today seem to be giving satisfaction. Present day methods of making cement joints do not secure

watertight joints and if compounds are proving satisfactory they should be adopted by every engineer. It is certain that if compounds will prove durable and tight joints can be secured under all conditions that such methods of sewer construction should be universally adopted even if they cost from 10 cts. to 15 cts. per foot more than cement joints.

It has been observed that troubles from excess infiltration are more noticeable in the Cameron type of septic tank than in the Imhoff. Wherever a place is found where water is sure to be encountered the installation of a larger Imhoff tank, than would otherwise be needed, would be one way out of the difficulties. It has also been noticed that the deeper the Imhoff tank the less troubles are encountered. It is the opinion of the writer that more use should be made of the two-story tank and that the engineers refrain from installing the shallow type of tank, except where it is absolutely necessary to do so.

But, no matter what we might suggest as remedies for systems that are yet to be built, this does not relieve the troubles of the plants now in operation. Several of the plants in Iowa that have given trouble have been provided with a shut-off valve that governs a by-pass line. This may, on the face of it, seem to solve the trouble but when we stop to think that most of the plants are located outside of the town and that it often rains at night it is really absurd to believe that a caretaker will rush out to the plant and open the valve to relieve the tank at all hours.

In order to eliminate this human factor the best scheme yet devised to overcome the difficulties seems to be in the installation of an overflow weir. An adjustable weir should be so placed in a manhole, near the plant, that when the pipe flows above a certain height it will overflow into a by-pass line, thus relieving the treatment plant of excessive waters. It is far better to let some of the water escape directly into the stream at time of storm than to put the treatment plant out of commission trying to force it all through.

Sewage treatment plants are built to reduce the sewage of a community to a non-putrescible state. The fact that there are only 190 plants in the State does not mean that all the other communities will get by forever without one. It is predicted that many more treatment plants will be built in this state during the next 25 years, but just because a community is not contemplating the installation of a sewage treatment plant at this time is no sign that the pipe system should be poorly constructed. Sewer systems in Iowa are not built like they should be. The whole idea of the contractor seems to be that of throwing the pipe into the ground any old way and if the engineer attempts to force good construction he is immediately "black-balled" by the contractors.

It has been stated that many treatment plants in Iowa are suffering today because of excessive water of infiltration and I have pointed out a few causes of excessive infiltration. If this State is desirous to keep in the race of sanitary progress and keep its streams free from pollution we must urge many more towns to install sewage treatment plants, but if we are going to build high priced treatment plants, only to stand idle because they cannot be operated properly, I for one would advise against the building of treatment plants altogether. Engineers must either work toward designing plants so simple and so fool proof as to operate almost mechanically under all conditions, or improve in the design of the sewer line and house connections. Contractors must either be made to understand that it is important to exclude all unnecessary water from the sewer by laying the sewer pipe on a good foundation and then make every joint as tight as possible, or be prohibited from completing the job. Present day methods of constructing sewers in Iowa do not tend to secure watertight joints and it is the opinion of the writer that it is the engineer's duty so to mould public opinion as to make it possible to design and construct a sewer system in such a way that it will actually perform the work for which it is built.

The foregoing paper by Mr. Pedersen was presented at the recent annual meeting of the Iowa Engineering Society.

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# THE USE AND ABUSE OF HIGHWAYS

*By T. J. Wasser, State Highway Engineer of New Jersey, State House, Trenton, N. J.*

I wish to present what I have observed, investigated and studied for the past eight years, relative to the use and abuse of our highways.

It was in 1915, while I was County Engineer of Hudson County, New Jersey, that I first took up the subject with Wil-

liam L. Dill, Commissioner of Motor Vehicles of New Jersey, and stated that it was necessary to have additional legislation to protect the highways from the abuse brought upon them by commercial motor vehicles as they were being operated at that time.

The Commissioner immediately appointed a committee, of which the writer was made chairman, to investigate and report on the matter. This committee, after a year's work, submitted a report which was immediately incorporated into a legislative bill, introduced, passed and is at present a part of the New Jersey statutes.

My investigation and studies since that time, and more particularly during the year 1920 when I served as a member of the Motor Traffic Commission appointed by the Hon. Edward I. Edwards, Governor of New Jersey, have convinced me that, due to the growth and development of the motor industry, the fundamental principles involved in the financing, design, construction, maintenance and use of the highways no longer constitute a state proposition, but that it has become a national matter.

Much good work has been done by various individuals and organizations throughout the country looking toward this end. Literature has been published, and many articles written, but in nearly every case the author has presented the matter from his viewpoint alone, without giving consideration to the needs of others, and no concerted effort has been made, on broad lines, to bring the several interested parties together. The National Highway Traffic Association did attempt this; in fact it held a meeting in New York City, which I attended, and at which the several interests were represented. However, at the end of this meeting, the views expressed were just as far apart as they were before, and they are just as far apart today.

My experience in public life leads me to make the following statement: "There is a solution for every public problem if we eliminate the selfish interests involved," and I make that statement as applying to this problem.

Other attempts have been made to reach a satisfactory conclusion by conference, but without success, either in whole or in part. The pamphlet entitled "State Regulation of Motor Vehicle Common Carriers" issued in 1922 by the Motor Vehicle Conference Committee, affiliated with the National Automobile Chamber of Commerce of New York, cites the arguments presented for and against State control of common carriers. That is only one phase of the subject, and a final solution of it was not found by that committee, although state regulation of the automobile carrier is already well established in many jurisdictions.

President Harding's address to Congress under date of Dec. 8, 1922, treated this phase of the subject as follows:

*Problem of Transportation*

"Manifestly, we have need to begin on plans to co-ordinate all transportation facilities. We should more effectively connect up our rail lines with our carriers by sea. We ought to reap some benefit from the hundreds of millions expended on inland waterways, proving our capacity to utilize as well as expend. We ought to turn the motor truck into a railway feeder and distributor instead of a destroying competitor.

"It would be folly to ignore that we live in a motor age. The motor car reflects our standard of living and gauges the speed of our present day life. It long ago ran down simple living, and never halted to inquire about the prostrate figure which fell as its victim. With full recognition of motor-car transportation we must turn it to the most practical use. It cannot supersede the railway lines, no matter how generously we afford it highways out of the public treasury. If freight traffic by motor car was charged with its proper and proportionate share of highway construction, we should find much of it wasteful and more costly than like service by rail. Yet we have paralleled the railways, a most natural line of construction, and thereby taken away from the agency of expected service much of its profitable traffic, which the taxpayers have been providing the highways, whose cost of maintenance is not yet realized.

"The federal government has a right to inquire into the wisdom of this policy, because the national treasury is contributing largely to this highway construction. Costly highways ought to be made to serve as feeders rather than competitors of the railroads, and the motor truck should become a co-ordinate factor in our great distributing system."

The writer feels that the right to regulate against abuse of the highways, based on fundamental principles, should

also be taken into consideration in connection with the solution of the "Problem of Transportation." If this is a matter for Congress to decide let us present the facts at once.

*"Highway" Defined*

The writer has been using the term "Highway," and before making specific statements regarding the use and abuse of the highways, he desires to differentiate between the dictionary definition of the word "Highway" and the meaning of the word in this paper.

Funk and Wagnall's New Standard Dictionary of the English Language gives as the definition of "Highway":

(1). "A specific line of travel, by land or by water over which a right or easement is enjoyed by the public of freely passing; a public thoroughfare, as distinguished from a private way.

(2). In law, a generic name for all public ways, whether by legislation, dedication, or necessity.

(3). A main road as distingushed from branches and byways of minor usefulness.

(4). A common or open way or course."

In this paper, however, the term "Highway" will always refer to a graded roadway of a main public thoroughfare upon which is constructed a durable pavement of sufficient width and thickness to permit of two vehicles of the maximum size carrying the maximum loads permitted by law to pass each other safely and with sufficient clearance at the maximum legal speed.

*Use of the Highways Prior to Completion*

The highway during its period of construction is the greatest medium through which desirability of equipment, materials, products, and methods that enter into its construction are determined, and records properly and accurately kept during this period are of inestimable value for future consideration.

Experimental road work carried on by a state should be done in conjunction with the Federal Bureau of Public Roads, even though the work is financed wholly by the state. Such a procedure would eliminate much duplication of effort, would lead to the establishment of a uniform system of securing and recording information, and would provide for the dissemination of such data among the other states. It is especially desirable in the case of materials, methods and appliances controlled by their producers that conclusions, based on actual use on experimental sections, be digested and transmitted by the Bureau rather than by the agency having a commercial interest in the article.

*Abuse of the Highways Prior to Completion*

While highway construction is rated as the fifth industry of the United States there is a lack of co-operation among the several interests involved, with a resulting unnecessary added expense. This can best be corrected by recognizing the several component parts of the industry, and by standardizing as nearly as possible the products used and methods employed.

There should also be full recognition of the importance of the highway industry by the Interstate Commerce Commission and State Public Utility Commissions in the fixing of equitable freight rates on materials used in highway construction. Reasonable open top car service also should be provided at times when preference is given to carrying coal. The latter requires intelligent regulation in place of the drastic action that has been experienced in the past few years.

The greatest abuse often comes to a highway before it is built, namely, failure to provide adequate drainage, faulty judgment as to type and width of pavement, and choice of location to suit certain interests.

There are frequently abuses in connection with financing, design, and construction of our highways. Some of the more evident of these abuses are:

Making the term of bonds longer than the life of a pavement.

Failure on the part of the engineer to provide a design and type of construction to meet the requirements of modern traffic.

Faulty construction on the part of the contractor for personal profit.

Inefficient inspection due to lack of knowledge, and to insufficient salary being paid to attract capable men.

Acceptance of inferior work.

Permitting inferior material to be substituted for that specified when delays are brought about by conditions beyond the control of the contractor.

Sacrificing quality for speed.

Failure to provide for a satisfactory well marked and maintained detour during the period the highway is under construction.

Designing and building bridges for a

live load less than that for which motor vehicles are licensed and narrower than the graded width of the highway.

Failure to provide for the elimination of railroad grade crossings.

Designing underpasses with a head room less than 14 ft. in the clear.

Lack of co-operation on the part of public utility companies and municipalities. The highway departments should advise all interested utility companies and municipalities as soon as a highway project is decided upon, and these interested parties should immediately proceed to perform all necessary sub-surface work, thereby eliminating delay in the progress of construction and the necessity for opening the pavement in the near future.

Absence of caution on the part of bonding companies. Bonding companies becoming surety for inexperienced persons who are operating under the guise of contractors or construction companies jeopardize the interest of the State engaged in highway construction. They should limit the surety to a fixed amount for the first contract, increasing the surety on the second contract, and so on until the applicant establishes his responsibility for carrying out contracts of magnitude.

The tendency of contractors to bid too low. This fault has had more to do with the performance of inferior work than any one other cause, and inexperienced contractors just entering highway construction are chiefly responsible, yet the bonding companies will go on their surety just the same as they will for experienced contractors.

Use of inferior material. Competition in manufacturing or producing material used in construction is such that inferior material is frequently put in competition with satisfactory material, and by under selling is used in the work. In many cases where inferior material has been rejected by engineers and officials they have been charged with favoring some particular material or product for reasons other than its merits.

It has been definitely determined that excessive use of water in mixing injures the quality of concrete, yet in many cases engineers, contractors and inspectors still permit the use of excess water. The contractor permits it because his force can turn out more work, and he claims it just as good. The inspector tries to remedy matters, but is unsuccessful. The Chief Engineer can not see all the work, and a subordinate in carrying out his Chief's desires is accused of retarding the progress of the work. However, anything that tends to add unnecessary cost to the construction and maintenance of the highway should be considered an abuse just as much as should a violation of the provisions set down to protect it.

All these abuses should be corrected at once, and the industry protected by the soundest kind of financing, engineering design, faithful construction and efficient inspection.

### *The Use of the Highway After Completion*

The use of the highway is very ably defined by quoting from the report of the War Department Claim Board in their reply to the State of New Jersey's claim on behalf of several of its counties, whose roads failed under the conditions exacted by the use of them by army transports during the War period, which reads as follows:

"With reference to your claim, and that of several counties in the State of New Jersey, for compensation covering repairs to roads which were used by government trucks traveling between the different munition plants and camps in said State, you were advised that this Board, after carefully reviewing all the evidence and circumstances in connection therewith, has denied the claim."

The following is taken from report of the Board:

"The roads, even though they were owned and maintained by the counties, were public roads and were open to lawful use by any individual or organization which desired to use them.

"If the power of a state to control its highways has not been delegated and the state has prescribed no conditions limiting or regulating the use of the highway, the people are at liberty to use it for travel, transportation, and communication subject to the condition that such right neither interferes with the lawful uses of the street nor invades the rights of the owners of abutting lands."

The Assistant Secretary of War has approved the findings and recommendations of this Board.

From the foregoing statement it is quite clear what is considered the use of highways. That the roads in question failed under army transport traffic is evidence that they were not designed nor constructed to withstand modern traffic.

Their failure should not be charged to abuse due to traffic, but should be charged to abuse by the governing body financing, designing, and constructing such roads.

At the present writing I am safe in saying that every state has many miles of such inadequately built roads, the upkeep and maintenance of which is out of all proportion to the service which they render. It is, therefore, necessary that only such highways as are efficiently financed, designed, constructed and maintained be offered to the public for use, in order that fundamental principles may be laid down that will make possible the establishment of regulations for the use of the highways.

*Abuse of the Highways After Completion*

Abuse of the highways is generally caused by a small percentage of users. Such abuse frequently results in accidents, causing injury and loss of life and destruction of property.

Law enforcement alone will not overcome these conditions or decrease the number of traffic accidents. The problem requires: first, adequate traffic planning, and second, proper enforcement of regulation according to the plan.

My deductions have been derived largely from observations of conditions in the more thickly congested sections of the country, and it is quite possible that some modification of my suggestions would be necessary to make them applicable to more sparsely settled communities. However, the fact must not be lost sight of that density of traffic increases rapidly with road improvement, and that provisions must be made for an unanticipated increase. Furthermore, right of way, grading, and major drainage improvements are practically permanent, and should be taken care of, once for all, in the original construction.

It is only necessary to observe the traffic conditions in any of our cities or upon our highways to appreciate the necessity of a wise and equitable policy of supervision. Such a policy must be drawn so as to prevent destruction of life and property.

In order to enable those whose duty it may become to work out an equitable and uniform plan to prevent the abuse of the highways, the writer recommends:

That the minimum graded width of all main highways be not less than 30 ft.

That this graded width be kept clear of all encroachments.

That all traffic rules be made uniform.

That a system of marking one-way streets be adopted, which will be uniform as to type and location of the markers.

That it is desirable to standardize all directionary and cautionary signs as to color and marking, and that posting signs other than directionary and cautionary on the right of way be made unlawful, and subject to a fine for each offense.

That the erection of signs on property abutting on the highway at curves, railroad crossings and intersections be discontinued, where such signs would obstruct the view of those using the highway.

That it is desirable to standardize colors to be used for degree of danger where illuminated signs are used, for instance, red at a railroad crossing or dead ends of highways, green for highway intersections, and amber for grades and curves.

That a uniform traffic regulation be adopted for intersecting highways to be in effect in the absence of traffic officers.

That a uniform maximum height, width, and length of vehicle be adopted.

That a uniform gross weight of vehicle and load for each class of commercial motor vehicle be established.

That all gas filling stations be located on property abutting on the highways, and not on the right of way; and that all gas filling stations shall display a visible tag on each pump, which shall be placed there by the State Department of Weights and Measures certifying as to the accuracy of said measuring device.

That parking of vehicles on both sides of a highway opposite each other, where a minimum distance of 20 ft. between the vehicles is not provided, be considered a nuisance and be made punishable by a fine.

That the erection of all booths and stands for the sale of goods within the right of way, and displaying farm produce in containers within the right of way be prohibited, and that the use of vehicles for retailing wares along the highway where such practice would cause persons to congregate on the paved portion be also prohibited.

That a uniform penalty for operating a defective motor vehicle on the highway should be provided. It is not the purpose of this paper, nor is the writer qualified to discuss automobile design; however, there is a common defect particularly in trucks, the correction of which would eliminate one source of danger. Tail lamps frequently fail to function due to

the wires having been damaged by abrasion or exposure to splashing water. It would seem to be an easy matter for the designer to provide protection for these wires. Other defects that the writer has in mind are broken or improperly adjusted brakes and badly worn tires.

That legislation be enacted to provide against motorists running past barricades on roads under construction, and destroying unfinished work.

That sidewalks be provided for the use of pedestrians along the highway adjacent to built up communities.

That pedestrians using the highways in the open country shall walk to the left, and that operators of all vehicles drive to the right.

That when one piece shipments that exceed the maximum weight allowed by law are made, they shall be shipped on specially built vehicles so designed as to distribute the load in a manner consistent with legal requirements, and only after obtaining permission from an authorized source.

That a uniform distinction be made between maintenance, betterment and reconstruction in order that comparisons may be made.

That motor vehicle taxation or license fees should not be any greater than that required to provide the sum necessary for maintenance of the highways.

That overloaded trucks being operated on the highways, when apprehended, be seized and held for a period of not less than five days, stored at the owner's risk and expense, and in addition the owner fined, in accordance with a penalty fixed for that offense.

That hauling companies, who contract for shipments by the ton, when caught overloading their vehicles, should have their license revoked, in addition to any other penalty.

That all operators of motor vehicles should be licensed, and that they be prohibited from operating a vehicle for more than twelve consecutive hours followed by eight hours' rest.

That, in addition to any uniform motor vehicle law previously recommended, all applicants for driver's license or renewal of same be required to submit a physician's certificate bearing date not more than one month back of the date of application. Certificate should be accepted only from designated physicians, and should certify that the applicant is in fit mental and physical condition to operate a motor vehicle.

That the examination for driver's license require the applicant to be able to read and write English, and that license be granted only to citizens of the United States with provisions for tourists from other countries.

That the owners of all motor vehicles must carry liability insurance for each vehicle operated.

That all vehicles, both motor and horse drawn, be equipped with a clearance light visible from front and rear. This light should be of a shape other than round, located on the extreme left side of the vehicle or load if over width, and showing green in front and red in rear.

*Fundamental Principles*

Fundamental principles are those which can be applied to the financing, design, construction, maintenance and use of the highways similarly in each and every state in the Union.

*Financing Highways*

It is the duty of the Governing Body charged with the financing of highways to provide funds for construction, either by bond issue or direct tax, using funds derived from the licensing of vehicles and drivers for maintenance only.

*Design and Construction of Highways*

The design and construction of the highway must first provide for a graded roadway properly and sufficiently drained and of a minimum width of 30 ft. Such a roadway should be free from sharp curves, steep grades, and all obstructions, including ditches, rocks, poles, fences, signs, drainage head walls, narrow bridges, trees, shrubbery, gas filling stations, etc.

The design and construction of the paved surface must be such as to meet the demand of regulated modern traffic. It must be of sufficient width to permit two vehicles of a size within the legal limits to pass each other at the legal rate of speed with safe clearance, and without danger of collision. In cases where such a width is not justified, it is recommended that half-width pavement be constructed with one edge on the ultimate center line rather than centering a narrow pavement on the graded way. Such an arrangement will best adapt itself to future widening, and in the meantime permits of the maintenance of an adjacent earth road. Local conditions will govern in the selection of the side to be paved, but as a rule it should be on the right hand side going towards market.

It must be of a type of construction to

permit carrying vehicles loaded within the specified legal limit, without injury to the pavement.

The construction of the highway depends upon the faithful performance, trained knowledge and ability of those engaged to carry out the provisions of the design.

*Maintenance*

The maintenance, in addition to upkeep, should provide for keeping the highway open for traffic, free and clear of all obstructions at all seasons of the year. Particular reference is made here to the care that is necessary to keep the shoulders adjoining the paved surface from being worn away. Excessive work on keeping up the shoulders flush with the pavement is due to insufficient width of paved surface, and should be charged to faulty design. The minimum width of the paved surface of a highway should be classed as a fundamental principle.

Maintenance should be of the highest order, in place of permitting the road to go to pieces for lack of attention to the drainage system and the ordinary wear and tear on the surface. Maintenance does not mean the restoration of a road that was faultily constructed or a well constructed road that was injured by overloaded vehicles.

If the principles set out are followed, then the highway is ready for use. If not, then I firmly believe the highway has been abused before it has been subjected to use.

Aside from the foregoing fundamental principles of the financing, design, construction and maintenance of the highways, the writer firmly believes that all the recommendations made by him to prevent the abuse of the highways, are fundamental principles for the regulation of the use of the highways, and that some action should be taken by this Association eventually to make them effective.

The foregoing is the text of the presidential address delivered by Mr. Wasser at the recent annual meeting of the American Road Builders' Association.

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## FIFTEEN MILLION PEOPLE LIVE IN ZONED CITIES

More than 15,000,000 people live in zoned cities, towns and villages, according to information made public recently by the Division of Building and Housing of the Department of Commerce. Computations show that the homes of 27 per cent of the total urban population of the country are located in zoned municipalities, and it follows that most of these homes are protected from intrusion of garages, stores, warehouses or manufacturing plants.

Zoning regulations provide, by a neighborly kind of agreement, that a city or town shall be divided into districts in which the uses for which structures may be built, their maximum height, and the area of the lot which they may cover, are established. In line with the zoning plan, certain districts are set aside for residences, for apartment houses, for office buildings, and for manufacturing. Ample provision is made for normal growth of business and industrial districts, but the builder of a garage or factory is not allowed to erect it within a residential neighborhood regardless of the annoyance and money losses inflicted on surrounding home owners.

The Department's investigation shows that in 1922 zoning spread especially rapidly in smaller places. Fourteen towns with five to ten thousand inhabitants were zoned during the year, bringing the total zoned towns in this class to twenty-three. Twelve places with 5,000 inhabitants or less were added to the list in 1922, bringing the total in that class to seventeen. The percentage of large cities which have already zoned remains much greater, of course, and of the 50 largest cities in the country, 22 have zoning ordinances in effect.

In the entire country, 109 cities, towns and villages were zoned January 1, 1923, as compared with 55 just one year before.

New York, the largest city in the country, has been zoned since 1916, and in contrast, the smallest zoned community had only 131 inhabitants according to the 1920 census. Eighty-one per cent of the urban population of New York state lives in zoned municipalities. California ranks second among the states with 71 per cent of her urban population zoned; Minnesota, third, with 58 per cent; New Jersey, fourth, with 57 per cent; and Utah, fifth, with 55 per cent. The entire District of Columbia is zoned.

In number of places zoned, New Jersey leads with 31; New York is second with 17; California, third, with 14; Illinois, fourth, with 10; Ohio, fifth, with 9; and Massachusetts and Wisconsin follow with six each.

The complete list of zoned municipal-

ities, as of Jan. 1, 1923, with references to the state acts under which zoning is permitted, may be obtained from the Division of Building and Housing of the Department of Commerce, which also has available for distribution such pamphlets as "A Zoning Primer," explaining in popular style the elements of zoning, and "A Standard State Zoning Enabling Act," a model act for the assistance of states in preparing laws permitting city zoning.

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## PREPARATION OF STONE AND GRAVEL FOR ROAD MAINTENANCE

*By A. H. Hinkle, Superintendent of Maintenance, Indiana State Highway Commission, State House, Indianapolis, Ind.*

(A) Gravel as used in road work might be classified as follows:

(1) Bank or Bar Run Gravel.

(2) Screened or Prepared Gravel.

(3) Crushed Gravel.

(1) *Bank or Bar Run Gravel* is so variable that the term means but little except in a particular job or as it applies to a particular bar or pit. Many pits or bars furnish native mixed material which is very satisfactory for use in gravel road work. Where bank gravel is intended to be used the specification should be made accordingly—the object of the specification being to secure the best grade of bank gravel which it is practical to secure in that particular locality. It is poor practice to specify a bank gravel and then draw a specification that cannot be met by any gravel in the neighborhood. Carelessness in writing a specification and then even greater carelessness in seeing that the specification is reasonably lived up to, has gotten many an engineer and contractor in trouble and occasionally the board of accounts is called in to "clear up the muss" and fix the responsibility for the specifications not being properly carried out. This carelessness in writing specifications and then the difficulty of getting them lived up to has encouraged, in some places, a specification which is in reality no specification at all. For instance, in one particular locality the only specification for gravel to be used in gravel roads and concrete work is, "It shall be a good cementing gravel." The specification might as well have said, "a good gravel" and stopped at that.

I will very frankly admit that it is not the easiest thing in the world to prepare a definite specification for each particular locality, which will secure the best local material which it is practical to secure. However, after sufficient study of the subject is made by the engineer, he can arrive at a proper specification. The State Highway Department of one of the states, just a few years ago, found it so difficult in attempting to apply the same specification to every community, that one of their representatives in explaining their troubles said that they finally became discouraged and threw away the specifications entirely and used such gravel as was available in each particular community.

The specification should be definite enough that a good contractor would ordinarily know whether bank run or prepared gravel would be required. If it is impracticable to secure the gravel specified, greater care should be taken thereafter in prepairing the specification. A practice which should be of assistance would consist in submitting to a laboratory, for a test, samples of the local gravels which it is believed would be satisfactory for the road work, and then prepare a specification according to this test which would permit these gravels to be used. In this way the poorer local gravels would be eliminated and the best local gravels allowed.

Owing to the small cost of the little equipment needed to make a screen test on gravel and the ease with which this test can be made, every county should be equipped to make this test. Quite frequently the governing factor will be the percentage of gravel which will pass ¼-in. circular opening or a No. 8 or No. 10 mesh sieve. With a little pair of scales and screen and two buckets, one can make this test in the field quite as well as in the laboratory.

The gravel banks and bars of Indiana, are almost universally found with an excess of sand. Owing to this fact quite frequently a roadbed can be built up of the local material, and thereafter the wearing course put on and replenished by using a better grade of gravel or stone from the commercial plants. In this way a properly sized and good quality of material is furnished as a wearing surface and a large initial cost saved by using the bulk of the cheaper material for a foundation which of course will not be as good as the better grade of material which might be shipped, but which may be as good as the traffic and finances available will justify using.

(2) *Screened or Prepared Gravel* is quite as variable in its make-up as is the

bank or bar run gravel. The product from any plant naturally depends upon the native supply and the degree of screening and washing that is done.

Dry screening is satisfactory to take out the over-size gravel but it is seldom satisfactory to take out the fine sand because of the difficulty of the fine screens clogging. Even the shaker and vibrator screens apparently are not proving satisfactory for dry screening gravel. While a dry screening plant will work in a very few exceedingly clean gravels where the sand and gravel particles are exceedingly hard and are almost totally free from clay and silt, such ideal conditions for its use are seldom found.

A washing plant whereby the silt and clay are removed from the gravel by streams or sprays of water and the gravel and sand sorted by screens aided by the flowing water, is usually the most practical method of cleaning and sorting gravel and sand.

To make clean aggregate for concrete the washing is a necessity in most plants. However, while the coating of the pebbles and sand grains with silt or clay is objectionable when same are to be used in concrete, it is not objectionable where the gravel is to be used in a gravel road. On the other hand it is a real advantage provided, of course, there is not an excess of the silt or clay. Hence if it were practical to secure the dry screened material for gravel roads, it would frequently be more desirable than the washed material.

Owing to the great variety of material that can be furnished by different gravel plants, it may be necessary to vary the specifications in cases to accommodate the product from the various plants. It is quite easy to say that a definite specification should be prepared and universally used. Although a certain specification may produce best results on the road, it may be economy in many cases to depart from this specification, if you are going to pay dearly for using it.

(3) *Crushed Gravel*: Prepared gravel made by crushing the over-size boulders in the gravel makes a product superior to uncrushed gravel for road maintenance purposes. The mixture of any amount of the crushed gravel with the uncrushed gravel aids it in compacting. A mixture of ½ crushed and ½ uncrushed gravel is quite frequently used and produces a very good material.

*Specifications*

(4) *Sizes*: The maximum sizes of gravel which it is desirable to use for various purposes may be listed as follows:

| | |
|---|---|
| Sub-base course | 6-in. |
| Base course | 2½-in. |
| Top course (not less than 4-in. deep) | 1½-in. |
| Future maintenance | 1¼-in to 1-in. |

If the gravel runs exceedingly fine as it usually does in the Indiana pits, a 1½-in. maximum size for maintenance may be used very satisfactorily; however, if the gravel runs coarse or crushed gravel is used, 1¼-in. or 1-in. should be the maximum size used for general maintenance purposes. Much trouble and annoyance has been caused by the use of too large a maximum size of aggregate in the maintenance of gravel roads. The large sizes do not permit the drag to smooth up the surface so well as when the finer sizes are used, and the surface is inclined to wear rough and uneven more rapidly with the coarse gravels in the surface.

The minimum sizes that might be used are preferably not to exceed 40% through ¼-in. and 10% through a No. 10 screen and 5% through a No. 30 screen; although gravels containing as high as 60% through a ¼-in., 18% through No. 10 and 8% through a No. 30 screen are used frequently with very good results. The most objectionable material is the excess of very fine sand and even material practically all passing the ¼-in. with not to exceed 18% through No. 10 and 8% through No. 30 screen, can be used as a skim coat in the maintenance of a gravel road with very fair results if the traffic is light. This brings us down almost to the sand-clay roads which give very fair results under light traffic, but which ravel quite badly during the dry season and cut up quite badly during the thaws, where heavy traffic comes on them.

It will thus be seen that the excess of very fine sand is the most objectionable part of many gravels and if this is controlled and the over-size gravel eliminated, we can allow a very large variation in the grading of the internal sizes and still get a very good gravel road. While a gradation of the gravel and sand grains from the largest to the smallest is desirable, especially where a heavy coat of gravel is placed, as this gradation makes a dense mixture and aids materially in compacting the gravel, yet this requirement may be sacrificed to a very large degree if we eliminate the over-size gravel and the excess fine sand, for these two latter requirements are the most essential.

It must ever be remembered that the expense which we are justified in creating in specifying a better and more expensive grade of material, depends upon the amount of traffic we are serving. Certain places in the State the local gravel is of such poor abrasion value that we find one yard of good gravel or stone which has to be shipped, is equal to two to three yards of local material, besides the better grade of material produces much less dust during the dry season and much less mud and slop during the thawing. Hence the use of the better material in these particular places, secures results which may far outweigh the additional cost where sufficient traffic is served. However, one should not be caught shipping material long distances and hauling at great expense to build a road when a local material practically as good may be found near by. A departure from this economic law in road maintenance has frequently started the taxpayers grumbling.

To determine which of such materials to use is one of the responsibilities of the road official whoever he may be. We will find much ground for a difference of opinion frequently, but if our knowledge is based upon sufficient observation and investigations, these opinions would not so frequently be at variance.

(*B*)—*Crushed Stone*: Crushed or broken stone has been used in the building and maintenance of roads for centuries. The method of its preparation might be classified as follows:

(1) Hand Broken.

(2) By Local (Small Portable) Crushers.

(3) By Large Commercial Plants.

(1) *Hand Broken Stone* for road surfaces and maintenance has almost entirely disappeared from use in this country. It is still quite extensively used in some of the foreign countries, especially the less civilized countries where the development of machinery has not progressed as in the United States. However, the hand breaking method is still used to some small extent in this State and in the hill portions of the country in general where small quantities of local stone are used for building and repairing light traveled roads. In such places shipping facilities are not available and it might not be economical to import a crusher owing to the small amount of stone that is used in any one place.

We have found it practical to use this method ourselves in a few cases in filling holes with local stone and in one case we have several miles of foundation stone which was broken with sledges after the stone was laid on the road. In new country where out-crops of good quality of limestone prevail at the roadside, this method no doubt will still be continued in use in building road foundations, as the large stone can be laid cheaply and only a very limited amount of sledging is required. Where limestone out-crops in the vicinity of the road and it becomes necessary to plug up breaks or mud holes in the road, I know of no more effective way to make a stable foundation hurriedly while the road is carrying traffic than by "sledging in" the large pieces of stone gathered from the field or local quarry. This coarse foundation stone must of course to be covered with fine stone, preferably of two sizes, the last coat not exceeding 1-in. in size.

Hand breaking caters more to the use of a coarser stone in the foundation which is exceedingly desirable, for if any great mistake has been made in modern road building to take care of the heavy traffic of today, it is in the use of too finely crushed stone for macadam foundation work. While hand breaking is a method of doing road work which in general belongs to past history, it is surprising to note how rapidly the process of breaking stone by hand can be done by an experienced bunch of laborers. Under special conditions such as these mentioned above, it will still be economical to use hand breaking in building foundations where it is not necessary to reduce the stone to a small size. However, for surfacing a road and maintenance work, the use of a modern stone crusher to prepare the stone is imperative.

(2) *Local (Small Portable) Crushers.* One of the advantages of the local or small portable crusher is that it can be transported to districts where out-crops of limestone are available and the stone crushed near the roadside and thus one of the expensive features of all road work, namely, that of the long haul, is reduced to a minimum. The disadvantages of the local crushers are (a) that it is more expensive to produce stone with a small crusher than with a large crusher; (b) It is difficult to produce the sizes that are frequently desired and the sizes that are absolutely necessary for certain classes of first-class macadam work. Of course it must be understood that the local crusher is only practical where suitable stone is found in the local com-

munity and an expensive haul or freight rate is saved.

As we build more and more the higher types of road, such as bituminous macadam and concrete roads, where the sizes of the aggregate are an extremely important feature of the work, the small portable crushing plants are not so suited for preparing the stone. They cannot sort and clean the stone so well as the large plants. I might cite as an illustration this past year where one of our contractors attempted to build a penetration road from stone prepared by a small local crusher located right along the side of the road. After spending most of the summer in attempting to secure the proper material from a small local crusher, he gave up in disgust late in the fall and shipped the remainder of the material from a large commercial plant at double the cost of what the local material was supposed to cost him.

However, if a sufficient sized crusher and proper screening plant is installed, any desired size and grading of stone can be produced from a portable outfit. We must weigh the cost, however, of such production, against the cost of the shipped material. With a local plant there is also only a limited demand for any one grade of stone and more difficulty will usually be experienced in disposing of the off sizes than from a commercial plant with shipping facilities, where there is a wider range of market.

(3) *Large Commercial Plants*: Inasmuch as the bulk of the stone we use is prepared at the large commercial plants, it is dealing with their output that we are mostly concerned. Large commercial stone plants should be equipped to produce any size of stone, and stone with any degree of freedom from dust.

Perhaps one of the defects in many plants is that they are not made so that they are sufficiently adjustable to different conditions, that is, so that they can shift from one size of grading of stone to another size without an expensive operation. This lack of adjustability in the plant is frequently caused by the lack of sufficient study and consideration being given the details of the operation of the machinery in designing the plant. It is best that the superintendent of every stone plant and the mechanic who may have direct charge of the designing of the machinery, should have emphasized to him, the importance of being able to shift from one grade of material to another when the demand of the output of the quarry makes it necessary, instead of resorting to the expensive method of storing stone or sometimes, as has been done, in shutting down the plant because all of the product of the quarry cannot be disposed of.

I one time happened upon a piece of macadam work where the specification provided that the maximum size of stone should go through a 4-in. circular opening. Some of the stone that arrived on the job was so large that it was quite evident that it had not gone through a 4-in. circular opening. I called by long distance 'phone the stone company's office and they assured me, after calling the plant and talking to their superintendent, that the stone was going through a 4-in. screen. I told them that I would be down to the plant that afternoon. After making a 60-mile drive across country and arriving at the stone company's office, I was told that they had made a further investigation and that it was possible that the screen was a 4½-in. screen. We drove to the plant, which is several miles out in the country, and after going up some 70 ft. in the air and looking at the screen in operation, the superintendent agreed that it might be a 5-in. screen. I prevailed upon him to shut down the plant so that we could meausre the size of holes whereupon we found that the screen was a standard 5½-in. screen and being an old screen badly worn in some places the openings in it measured as much as 5¾ ins. across. My experience on numerous occasions of this kind has led me to believe that too frequently the manager of a plant and even the superintendent does not give enough attention to the details of the screening, which is so important a feature of stone production in the preparation of stone for the building of the higher types of road.

*Overloading of Screens*: It is not uncommon to see stone coming from a screen with 20 to 50% of the material that would readily go through the openings in the screen over which it passes. This is usually due to the overloading of the screen. While the angle of the screen, size of openings and rate of revolution of a screen determines the amount of "fines" left in the product, yet every screen has a capacity, which, if exceeded, will greatly increase the amount of undersized stone left in the product. Sufficient screen capacity is just as important a part of the plant as crusher capacity.

*Removal of Dust and Clay from Small*

*Size Stone*: While use of the revolving circular screen is almost universal in stone producing plants, the separation of the dust from the finer sizes of material where it is imperative that those sizes be free and clean from dust, is now being done quite extensively by shaker and vibrator screens which perhaps clean the material better than by any other process. The ease with which the dust and fine material is removed from crushed stone depends very largely upon: (a) the percentage of clay that is permitted to go into the crusher and mix with the stone; (b) the moisture in the stone and clay; and (c) the hardness of the stone. It is very difficult to eliminate clay from the fine stone when it is damp as happens during a rain on the quarry, and when the clay has been put into the crusher with the stone. Where it is imperative to produce clean stone, as when the stone is used in concrete and bituminous roads, it is very imperative that great pains be used in stripping the quarry. During periods right after a rain if a little care is used in filling the cars in the quarry, frequently the freedom of the finer stone from clay will be very favorably affected. It is not uncommon to happen in a quarry after a rain in small plants where hand loading is done, and find the shovelers scooping up dirt, clay, stone and all into the small dump cars. One thing we can positively state is that if clay does not go into the crusher it will not come out in the fine stone. The harder and flintier stones naturally produce a cleaner, small size product than the softer stones.

*Sizes of Aggregate for Various Purposes*: There is such a large variety of sizes of aggregate used for various purposes, that it would almost make one dizzy to enumerate all of them. For this reason a number of years ago an attempt was made to standardize on the size of aggregates. This was done fairly satisfactorily. However, it seems that owing to the fact that difference in various city, county and state specifications and the different ideas of various stone crushing companies as to what size they should make, has caused us not to make much progress in this standardization of sizes. It is a fact, too, however, which must be taken into consideration, that stones of different hardness will permit the use of a little different size; that is, generally speaking, in macadam work the harder the stone the smaller should be the maximum size used for any particular purpose.

A general principle in the sizing of stone for macadam work might be to use as coarse a stone as can be used without causing an objectionable roughness of the particular type of surface in which the stone is used. The thickness of the surface course may determine the maximum size that can be used; that is, within certain limits a thin course will require the use of smaller size stone than a thick course. As a general guide the following might be taken as a limitation of sizes for various purposes:

*Waterbound Macadam Top Course*

(a) If surface is to be maintained in the future by the applying of fine stone and dragging, 1½-in. to ¾-in. size.

(b) If surface is to be maintained in the future with the use of bituminous surface treatments, 3½-in. to 2½-in. 1-in. to dust for soft stone.

(c) For filler ¾-in to dust for medium stone; ½-in. to dust for very hard stone.

*Bituminous Macadam*

(a) Covering stone for first application of tar or asphalt, 1¼-in. to ¾-in. size.

(b) Covering stone for last application of tar or asphalt, ¾-in. to ¼-in. size.

*Bituminous Surface Treatments of Tar or Asphalt*

(a) Treatments ⅛-gal. per square yard, ½-in. to ⅛-in. size.

(b) Treatments ¼-gal. per square yard, ¾-in. to ¼-in. size.

(c) Treatments 2-5-gal. per square yard, 1-in. to ½-in. size.

*Stone Road* maintained with light covering of stone and dragging operations:

(a) Very light application of stone—Hard stone, ¾-in. to ¼-in. size; medium, 1-in. to ¼-in. size; soft stone, 1¼-in. to ¼-in. size.

(b) Heavy application of stone—1½-in. maximum size may be used, preferably to be covered with one of the above sizes.

*Cold Bituminous Mix for Patching*

(a) To be put down with a roller or under very heavy traffic, 1½-in. to ¼-in.

(b) To be put down by hand tamping, ¾-in. to ¼-in.

While the above tabulated sizes are more or less the ideal sizes, quite a variation from these can be permitted in some cases, and yet first-class results be secured. In fact there may be certain

conditions where a departure from these sizes would be desired. For instance: Where a comparatively soft stone is used in bituminous and waterbound macadam to be later maintained by surface treatment, the larger size stone might better be a maximum size that will go through a 4-in. circular opening instead of a 3½-in.

While for foundation stone, in order to accommodate the quarry, frequently 2-in. or smaller stone has been used, it undoubtedly would be better to use a much coarser stone, even as large as would go through a 6-in. opening, if the stone is to be rolled and waterbound.

*(C)—Wise Location of Gravel and Stone Plants Necessary*

Proper selection of quarry sites and location of gravel plants both for the local plants and large commercial plants, is very important. Before capital is invested in such a plant, the gravel and stone should be tested for all depths and areas over which it is contemplated to develop the plant. Capital cannot be wisely invested unless this is done. Too frequently a quarry or gravel plant has been located only because it was considered an economical place to strip the stone or gravel. The saving in this respect in a particular location may be only a very small part of the cost of production which small saving might have been counteracted several times by the better quality of stone or gravel at some other location. One thing is certain, that if the quality of stone or gravel is not present to start with, a good product cannot be produced. In many places a plant would not have been opened up at all had sufficient examination been made. A plant that can economically produce good gravel or good stone is an asset to the state and the taxpayers profit thereby. A plant that produces poor grade material and does not operate economically is a disturbing factor to good society. A poor grade stone can frequently be produced cheaper per ton, than a good hard stone. This cheaper cost of production is too frequently used in maintaining a big lobby to force the sale of the poorer grade material to the road officials. In such cases the road official needs our sympathy. Here is where a laboratory test on the material may come to your relief. The good material sells itself and only necessitates a large promotional expense when the other fellow gets the best of the situation. Let us hope that everything possible will be done to overcome the over-promotion of poorer grades of material and material that is not economical to use. We can assist in this somewhat by being fair to the legitimate commercial plants which produce good material. Much capital is invested in them. They are an asset to the state and should be encouraged. We should not encourage the establishment of local plants because these can produce material about as cheaply on the road. The local plants should be encouraged only when beyond a doubt they can produce material on the road cheaper than the commercial plants, taking into consideration the quality of the material. The commercial plants have been hit an awful blow the past few years because of the unstable situation of our railroads and some of them will need nursing if they survive another similar condition. However, the economic law of production of road materials must prevail and if this fluctuating condition of our railroads is to continue in the future, the shipping of road material will have to harmonize with it.

*(D)—Talent Needed in Manufacture of Road Materials*

Although the road material producers, and we in the road maintenance and construction work, may feel too proud and bigoted to admit our work is not being done to the maximum efficiency, we will have to admit as part truth the statement some one has made, namely, "The brains of the world is now employed in the automotive industry!" This industry has paid bigger salaries and has offered greater inducement to our young men than the road work. Let us hope that we may stem the tide eventually, and direct back into the channels of road production some of the talent that has been going into the automotive industry. The advance that this industry has made over road production is too great. The road work should keep abreast, if not a few years ahead, of the industry which wears out the roads. The public must be made to see the truth. It is not consistent that an automobile owner should pay 12 cts. for operation expense for every mile he drives his car, and then object to paying 2 cts. gasoline tax which on an average amounts to 1-6 cts. per mile, in order to have good roads over which to operate the car. Any man who continues to study any subject and has a reasonable education, eventually becomes more or less of an expert in that subject. Cer-

tainly with more talent directed into the production of road materials, and doing road maintenance and road construction work the industry would be benefited.

The foregoing paper by Mr. Hinkle was read at the Purdue Road School, Jan. 23, 1923.

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# THE RESUSCITATION OF A WATER COMPANY

*By Farley Gannett, of Gannett, Seelye & Fleming, Inc., 1 N. Market Square, Harrisburg, Pa.*

A human being, when immersed in water, dies for want of air. This is a story about a water company, which nearly died for want of water when its reservoir would hold nothing but air. It was resuscitated by giving it water in its reservoir and forcing water out of its capitalization. It wouldn't have done any good to attempt filling the empty and leaking reservoir with water squeezed out of the capital stock as it wasn't the right kind of water.

The story, although essentially an engineering and financial one, has running through it a strain of humor, courage, trouble and romance, as most stories of this kind must have when all is told. Many years ago two young men, who later became famous in Pennsylvania history and politics, travelled through the rough and rugged hills of Cambria County, in Central Pennsylvania, on horseback, as there was then no other means of travel, looking for signs of the coal deposits which it was rumored were to be found in that region. They finally found what they sought, but it was far from railroads and there was no means of getting the coal to market if they mined it. The hardest task before them was to convince the distant railroad company of the value of the coal lands, and to induce the company to run a track to the coal field. This was finally accomplished, but how the result was brought about is another story.

The mine was opened and a village sprang up and grew about the mine. This village is now the Borough of Spangler, sprawled over about two miles of landscape in a narrow valley at the head waters of the Susquehanna River. It is so high up in the mountains that the streams thereabouts are all very small except the main creek in the valley, but that, due to mine water drainage and mine village drainage is not fit, and could not be made fit, to use for drinking water.

It soon became necessary to supply the village with water and these two partners, who were still young and struggling, and who had induced others to join in their coal development, decided to build a water works system to supply the town. Their associates joined with them, the village streets were piped and connected with a reservoir which was built about a mile from town. The water collected behind the dam, flowed through the pipes and into the miners' houses, stores, hotels and livery stables, and a little into the many saloons, and all went merrily as there was no pumping to be done and all the owners had to do was collect the revenues.

The water works business looked fine to these men who had been working so hard to make ends meet in the coal mining and as the town grew more houses connected to the pipe lines and the receipts increased, and there were no corresponding increases in the operating expenses. The partners looked at each other and said they wished the whole world was just one great water works system and belonged to them.

This story wouldn't be a bit interesting, if it stopped here. It certainly didn't because one fine day when one of the partners turned on the spigot in his house nothing but air came out. He jumped on his horse and rode to the reservoir and found it empty, where the day before it had been full. Where had the water gone? It was soon found that it had gone through the bottom of the reservoir into a coal mine. Another source of water had to be found. That is a short sentence and a simple one, but its meaning was portentous to these men. Water was scarce, and it costs a great deal of money to build reservoirs and pipe lines. There were coal workings under the nearby streams and they would have to go some distance to find a stream that was not underlaid by coal.

Finally one was found, where the coal was so far below the surface as to make it safe to build a reservoir, Brown's Run, by name, some 2½ miles distant and high enough so as to enable the continuance of the gravity system of supply, but it would cost $40,000 to build the reservoir and long pipe line and the stockholders of the water company were looking for money to come in and not go out. The town was without water, and the company had obtained a state charter which obligated it to supply the town. The people had built houses there depending on

the water supply and looked to their employers, who owned the water company, to furnish it to them. There was nothing to be done but to raise the money and build the new dam, so with fear and trembling the two friends approached their associates with the proposition and when the situation was explained the money was raised, but not without objections, hesitation and even flat refusal from some.

The dam was built, far larger than the former one, to store sufficient water to last the town for half a year even during a severe drought. The pipe line was 12 in. in diameter, compared with the old 6-in. line to the first reservoir. It was all built for about what it was expected to cost. The water was clear, pure and soft and out of danger of coal mine workings, and all was ready to run merrily again. But, when the valve in the pipe through the dam was closed to allow of the reservoir filling up, a small trickle of water appeared below the dam at one end, coming through underneath, and as the water rose in the reservoir this trickle became a stream, until the outflow equalled the inflow and the reservoir stood only about one quarter full. As soon as a dry spell occurred this water was used up and the natural flow of the small stream was so slight that the town didn't have sufficient water, so the only thing to do was to spend some more money and try to stop the leak. Grout was pumped into the underlying rock to no advantage and other means were tried, engineers made reports and explorations to no avail; still the water poured through under one end of the dam in undiminished volume and most every summer the town was dry. The railroad company, which had gladly contracted with the water company to use this pure soft water for its engines, had to go back to polluted, acid-laden creek water and the owners of the water company who lived in Spangler had their lives made miserable by complaints of lack of water all over town as soon as it stopped raining or whenever the sun shone for a few days in succession. The company didn't dare to take on new business and the consumers demanded and had to be given rebates when the water was short. It began to look serious, the company had issued bonds and couldn't pay the interest and of course had not paid dividends on the stock. Money to the extent of many thousands of dollars had been borrowed from the local bank to keep the property alive and there was no hope of paying the money back for it cost more to run the plant than was received in revenues. Everyone complained, consumers, bondholders, stockholders, banks and officers. Something had to be done, but what, no one knew. It looked as if the dam couldn't be made to hold water and there was no more money to be obtained for a new dam, but things couldn't go on as they were going.

Now, this is where the true story begins, the preceding introduction is word of mouth history, pieced together from fragments obtained from harassed officers, disgruntled bond and stockbrokers, angry consumers and the like. The archives of the State added other facts.

One day the president of the water company came into our office with the treasurer, and said they had a leaky dam that needed fixing. They had heard something to the effect that we thought we were good at that kind of thing. We admitted we were all that and would be glad to fix up their little old dam some Sunday when we were not very busy. We didn't know as much about that Brown's Run dam as we know now. We didn't know how many people had tried to fix it and we didn't know that the whole side hill at one end of the dam was a mass of rotten rock and that way down deep under the solid rock were holes big enough for a man to crawl through.

We examined the dam and obtained all the data we could, watched the water coming through the dam and thought we knew how to solve the problem. It looked comparatively easy. We had a meeting with several of the officers and directors and learned of the financial position of the company. Owing to the trials and tribulations which had been encountered, bonds, stock and notes in bank had piled up to such a figure that the company couldn't hope to add to it and continue the struggle with such a load on its back, even if the dam was repaired and made to hold water.

A plan was worked out by which these securities were reduced to reasonable proportions and the owners thereof agreed. Then a new first mortgage was placed on the property and as the estimated cost of repairs and improvements was $25,000, that amount of bonds was authorized to be sold. We then made a valuation of the plant and found that the rates were too low and decided to raise them 50 per cent! And to cap the climax, we decided to sell most of the bonds to the water consumers. That showed

some courage, you will say, gentle reader, and echo says it did.

The original partners, or their heirs, agreed to buy some of the bonds, and we did too, to show our confidence in the proposed method of repairing the dam. The rest of the bonds were actually sold to the consumers in $50 to $500 lots and the money was all raised. The reason why the consumers bought the bonds was that they hoped, as a result of this new money, to have an ample and continuous supply of water and they didn't object to the raise in rates because that insured the payment of the bond interest and nearly every consumer or his brother or friend bought a bond.

Then we started work on the dam. We emptied the reservoir, supplying the town with what was available in the stream, augmented by water pumped from a well once used by a brewery in the town. Then a trench was excavated near the upstream toe of the slope on the end of the dam under which the leak occurred. This trench was about 70 ft. long, and about 10 ft. below the level of the original ground we found rock for some distance in the trench bottom, but this rock suddenly stopped on a sharp fault line, the bottom turning into a dense yellow clay. This we concluded didn't leak and so devoted attention to cutting down into the rock until we found where the water was coming through. This rock was of an unusual nature in that for a considerable depth it would appear to be solid, undisturbed red sandstone lying nearly horizontal, and then on penetrating to a greater depth in this solid rock, we would find rotten, crevised rock below with large openings through it, through which the water was leaking. At a depth of some 30 ft. we encountered a large opening of this character and satisfied ourselves that this was the channel by which the water leaked out.

We backfilled the entire trench with good clay, borrowed from the hillside above the dam, puddled it well, closed the valve and waited for the water to rise. We had spent less than one-half of the money raised by bonds and were vastly pleased and satisfied, and again things were about to go merrily. But the water rose and the leak again appeared, not quite so great, but still too great to be permitted and too great to allow of supplying the town from the reservoir. We decided that the water was now coming under the extreme end of the dam toward the north hillside so we reopened the trench and uncovered the rock and continued northward to the very end of the dam where the crest meets the hillside. We went through layer after layer of good solid rock with rotten rock between, until we again found a large fissure and traced the reservoir water through it and out into the channel the leaking water had worn below the dam. Again we congratulated ourselves that we had discovered the source of the trouble and we backfilled with clay puddle and sat back to see the water rise in the reservoir and stay there, but it didn't stay there. It rose until the reservoir was about one-third full and then began to leak. Then came a heavy rain and the reservoir rose to about 20 ft. depth, to within 5 ft. of the spillway, and not only did the old leak increase, but a new one appeared on the other end of the dam under the spillway!

We still had about $5,000 of the bond money left, but it was late in the fall by this time and we decided to wait until the next spring before going at the leaks again. During the winter and spring there was plenty of rain and snow to keep the town supplied and by starting work early in April it was expected to have the leak stopped and the trench backfilled before dry weather set in, so the reservoir would fill.

So early in April the trench was again opened and extended into the hillside as it seemed certain that the water was going into the hill and around the end of the dam.

An order had previously been issued by the State that the spillway on the dam would have to be enlarged, if the leak was to be stopped. The State apparently admitted that as long as the reservoir couldn't be filled with anything but air, the spillway was large enough and paid us the compliment of anticipating that we would finally stop the leak, in which event the authorities planned another way for the expenditure of money the company didn't have and couldn't get. Nevertheless do it the company must, so we started that job, too, and also cut down the spillway to excavate a trench to be backfilled with clay puddle to stop the leak that appeared there last fall. With all of this work going on, and bond interest and note interest to meet, and a little less confidence in the ultimate outcome, the future wasn't quite so rosy.

But don't forget we had increased the rates 50 per cent and also, in anticipation of having plenty of water, pipe lines were laid in unpiped streets of the town and

quite a number of new consumers had been taken on, so the revenues were nearly twice what they were before. This helped out on the new work and we plugged ahead.

By this time I was afraid to meet the two partners, officers and directors of the company because of the sad and reproachful looks they always gave me, and that wasn't all they gave me sometimes, but don't think our troubles were over, or nearly so, the worst was yet to come.

For a third time a channel was found far down in the rock and for a third time water was seen coursing through it and was traced to the channel below the dam, and for a third time we cheered ourselves with the belief that our troubles were over and for a third time, and this time with great confidence the trench was puddled with backfill, and for a third time the valve was closed. We waited for rain to fill the reservoir. It came and some of it went right through under or around, or over, or through, or somewhere, but at any rate it appeared in the same old channel below the dam, but in still more reduced quantity. It did not rise high enough, however, for us to tell whether the leak under the spillway on the other end of the dam had been stopped or not.

The weirs, however, told us that for the same height of water in the reservoir the leakage was less than one third what it was originally and that with the reservoir full we could expect it would be no greater than enough to supply the town. The head from a point just below the dam was sufficient to give ample pressure to all parts of the town, so we conceived the idea of conserving this leakage in a small dam below the main one and abandoning any further attempt to cut off the water passing under or around the main dam.

We designed a small intake dam 7 ft. high and holding about a day's supply, with a feeder pipe to the supply line from it and estimated its cost and put the plan up to our partners, the officers of the water company. More money to spend—we told them it was the only hope and the only sure way to save the situation and that to cure the main dam of its ills we might have to go back a mile into the hill, etc. So they finally agreed.

We had already found that the company didn't own quite all the land necessary for this little dam, but as only two acres were necessary and as the land was brush covered waste land, unused and practically valueless, we were sure it could be bought for a song. The owners, a family of foreigners, were approached but they had already discovered our situation and saw why we needed their land and generously asked $1,500 for the two acres, worth $25 an acre. Ordinarily this offer would have been refused and the land condemned, but the State of Pennsylvania years ago decided that water companies were grabbers and trusts and altogether not to be trusted and the right of eminent domain was taken from them, so we had to negotiate with the owners and finally paid $700 for this little piece of land vitally necessary to us, but nearly valueless to the owners. Then we built our new intake dam and were again ready to have things go merrily.

Everyone has heard of the great drought which struck the East and particularly central and western Pennsylvania last summer. Well, it struck poor little Spangler and struck hard. It didn't rain any to speak of for six months from July, when the new dam was finished, until December. There were traces, and once in a while a thunder storm, but that was all. No water gathered in the reservoir and the stream, Brown's Run, dried and dried and dried, until the weirs warped in the hot sun.

Of course, there was no water to supply the town and the well we used the year before was again brought into service, but droughts affect wells too and in a few days it was pumped dry. The main creek in the valley was exceedingly low and thick with acid and other pollution, so it couldn't be used. In the meantime, with the weather hot and dry there was actually no water in the system and no place to get it apparently. Water had to be obtained somewhere, somehow, and investigation was made of every damp spot in the neighborhood. The matter finally resolved itself down to using water which was being pumped out of a nearby mine, and this we proceeded to do. An electrically operated pump was installed and connected by a pipe line, laid on the surface of the ground to the distribution piping system, and we had water, but such water. It was wet and had no bacteria in it. They couldn't have lived in it. All this only took about three days.

Of course, people didn't like this water, but they were glad to get anything and everybody in town or his neighbor or his brother, or brother-in-law owned bonds and so no complaints were filed. The State permitted the use of this water as it contained no disease germs.

Well, this went on for two months, with a little sprinkle of rain each month so that the pipes could be filled a day or two a month with good water, until all of a sudden the mine we were getting the water from blew up. The whole country heard of the explosion in the Reilly Coal Mine at Spangler last fall when 83 miners were killed. Well, that was the mine we were getting water from and our pump and pipe line and everything was blown in all directions.

Then, the first stroke of good fortune befell this little corporation—it rained all one whole day and for two days when the hospital was full of injured and the town was full of sadness and grief, the water pipes bulged with an ample supply of good pure mountain water and during this time the pump and pipe line and electric power line were repaired and when the rain stopped and the stream dried up, the mine water was again put to use.

About Christmas time rain and melting snow began to fill the reservoir, then more rain and more melting snow came, the mine supply was shut off, the pump dismantled and the reservoir filled gradually. The new intake reservoir was put into service and now the main reservoir is nearly full, more than it ever had in it before. The leakage is less than the daily needs of the town, and all goes merrily once more.

The bond interest has been paid, the supply now is assured, the reservoir is sure to fill this spring, and if it never rains all summer and fall this year, we will start with a full reservoir and can take care of everyone.

This is the end of the story—we hope.

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# WINTER ROAD WORK

*By John H. Mullen, Chief Engineer, Minnesota Highway Department, 12½ University Ave., St. Paul, Minn.*

The attention of road officials may well be directed to the problem of extending their work over the winter months, for road work is generally conducted as a seasonal activity and there is a period in the winter during which construction organizations and equipment are idle and for this period of idleness there is a loss, not only in progress of work, but also in the efficiency of the working forces, as well as in the cost of overhead and investment on equipment, which must be compensated for in the cost of work done during the summer months.

*Paying for Lost Time.*

Road building has become a business, engaging the attention of business men, and we would not delude ourselves with the idea that we are not paying for the time of the contractor and his principal assistants while idle, nor for the interest on his investment in equipment when not in use, for the road contractor, like other business men, is applying cost accounting and business methods to his work, or will have to if he continues to operate, and the public will pay the bill. Accordingly, any means whereby the fixed overhead and equipment charges can be spread over the whole year instead of being carried by a few months' work will be a direct saving to the taxpayer. This is the economic, engineering side of the question. Then there is the other phase, quite important, too, of providing winter employment for a part of the large army of men engaged in road work during the summer. True in some parts of the country there is still the opportunity for men and teams to obtain employment in the winter on such work as logging, but this work is diminishing and is also becoming an all-year operation which does not offer the chance for winter work to men from other lines, so that we have the further responsibility of taking care of unemployment, or be faced with the proposition of paying wages sufficient to carry men through the winter, for men must live and teams must be fed in the winter as well as the summer.

*Minnesota Experience*

The nature of road work makes the problem seem rather difficult, but our experience in Minnesota is that the situation can be greatly improved by planning our program of work well in advance. This applies particularly to grading, for every year we have a number of projects on which there is rock excavation, or heavy earth work, with deep cuts and large enough quantities to warrant the use of steam shovel equipment, which can operate on that work as well in the winter as in the summer. We find that if contracts for this kind of work are let in the fall, the contractor is thereby enabled to make use of steam shovel equipment to advantage during the winter, and can then hold a nucleus of his organization together through the winter, and also benefit by the lower wage scale prevailing at that time. This all makes for a lower unit cost of excavation and has the further advantage of

disposing of the heavy work in advance of the ordinary grading operation.

*Examples of Grading.*

An example of this kind of work is a last winter's job 5.1 miles in length, involving 172,600 cu. yds. of excavation, of which 110,167 yds. was rock, which was done at a price of 19 cts. for earth, 65 cts. for loose rock, and $1.30 for solid rock. Winter work cannot be credited entirely with these low figures, for the work was very heavy, averaging nearly 34,000 cu. yds. per mile, and the rock was a soft limestone, but attention is called to this job as being especially suitable for winter work. Another project is a 40-mile piece of grading on new location, now being done, on which the estimated quantities are 418,000 cu. yds. of earth and 130,000 cu. yds. of solid rock, which was let at a price of 45 cts. for earth and from 95 cts. to $1.60 per yd. for rock. This is in a timbered country, rather inaccessible, and the prices on this work are low when it is considered that there is no loose rock classification and the solid rock is a tough granite or trap rock. The variation in rock prices on this job is due to the fact that some of the rock excavation is along the bluffs on the shore of Lake Superior, which allows for side casting without any haul, and is being done at a price of 95 cts per yard while the rock work involving haul costs $1.60. Letting this work in the fall also allowed for all of the clearing on the line, about 316 acres, to be done in the early winter. On the whole, we believe that such conditions as existed on the two projects referred to and which prevail in a measure on a good percentage of our work, can be handled in the winter, or as combined winter and summer projects, to the advantage of all concerned.

*Gravel Surfacing*

In the northern states most of the roads are being improved by gravel surfacing. Taking again, as an example, the state of Minnesota, we find that in the past two years there were 1,675 miles of this kind of work done by the state alone, with an average of 1,500 cu. yds. of gravel per mile, or a total of about 2,512,500 cu. yds. of gravel hauled. In addition to this there were 1,750,000 yds. hauled by the counties on secondary roads. Of course, a portion of this had to be done in the summer time on account of wet pits and the necessity for shipping in cars, but we have found that a great deal of this material could be hauled most economically in the winter time, especially when long hauls were involved. This is due in part to the lower labor rates, but is principally due to the fact that when the roads are frozen smooth, and we make it our business to see that they go into the winter in that condition, the trucks or wagons, as the case may be, have the benefit of a surface to haul over that is as good as a concrete road, which permits of a maximum loading and consequently a lower unit hauling cost. As an example, last winter one contractor with a fleet of 26 trucks hauled 28,000 cu. yds. of gravel an average of 9 miles in 25 days. The contract price for this work was 20 cts. per cu. yd. mile, and the average truck load was 7 cu. yds. This would have been impossible in the summer time, not only because the contractor could not have hauled so cheaply over earth and gravel roads in the summer, but because we would not allow such equipment to be used on account of the damage or destruction of roads being hauled over. Summer gravel hauling is restricted for this very reason to pneumatic tired trucks, which of course, limits the loads to about 3 yds. In the past winter, Minnesota contracted 1,350,000 cu. yd.-miles of gravel hauling by truck at an average cost of 22 cts per yard mile. This compares favorably with the average cost of 27 cts. per yard mile for summer haul.

*Team Hauling*

Winter graveling is not by any means confined to truck hauling. Perhaps the greatest benefit of this work to unemployed has been where the material has been hauled by teams. A striking example of this is our experience last winter in a section of the State where farming and financial conditions had made it very difficult for some of the people to get through the winter. It so happened in that territory that a large mileage of grade was ready for surfacing and dry pits were available. Accordingly all the men and teams that could be used to advantage were put to work as an emergency measure and in all about 500,000 cu. yd.-miles of gravel were hauled at an average cost of 20 cts. per yd.-mile. This cost is low for team haul, but the team owners were anxious to have the work and were willing to work long hours to obtain the money so made available; in fact, while the engineers were able to place 340 teams on this work there was probably about one-third as many more who would like to have had the same opportunity. It is needless to say that this operation was of financial advantage to

the State as well as a means of taking care of a serious unemployment situation. Gravel hauled in the winter is generally deposited in continuous "windrows" on the grade, and is bladed to the proper section and compacted under traffic the following spring. While there is sometimes considerable loss of winter gravel due to muddy sub-grade conditions in the spring this is more than overcome by the lower cost of the winter work and by the advantage of having the surfacing deposited and in good condition before the road would otherwise be ready to carry any traffic. Even without these advantages, it is good business to haul this heavy tonnage in the winter in order to avoid the damage to earth and gravel roads over which the material must be hauled, and which are badly cut up by such hauling in warm weather.

*Winter Paving.*

At first thought it does not appear that much advantage is to be gained by winter work in connection with paving operations, but in this field there is an opportunity to not only cut the cost of paving work but also to save many of the delays encountered in the summer time due to shortage of material and congested shipping conditions. This can be taken care of if the highway departments contract their paving in the fall of the preceding year and provide for partial payment to contractors for materials produced and stock-piled. It is not reasonable to expect a contractor to purchase and stock-pile material during winter months unless provision is made to pay him monthly for doing that work, but if this is done there is an incentive for him to purchase and store his materials during the slack period, thereby furnishing winter employment to a part of his regular force, and what is more important, shipments may be made while cars are available and consequently the usual delays for lack of cars and aggregates can be avoided, and the materials may be bought at a lower price. The writer took this matter up with a number of operators of rock crushing plants, all of whom agree that if road contracts are let sufficiently in advance to allow for the continuous operation of crushers during winter months that the reduction in cost of producing rock would amount to from 12 to 20% below the cost when quarries are only operated during warm weather. The items making this possible are briefly: that an increased tonnage for the year decreases the interest and overhead charge per ton of output, as well as decreasing the depreciation and other fixed charges which are not dependent entirely upon plant operation. The labor turnover is less, for the same men may be employed throughout the year and the operator is also given the advantage of skill acquired by men continually employed in the same kind of work. There are, of course, disadvantages to winter rock producing such as the difficulty of proper lubrication, the breakage of castings, and added cost of protecting pipe lines, but in estimating the above stated decreased cost these things were taken into account. There are many other items of construction which can well be taken care of in the winter, such as the distribution and laying of track and pipe lines, the erection of central proportioning and loading plants, preparation of equipment, etc., but practically all of the winter construction work which can be done to advantage is predicated on the early letting of contracts and payment of monthly estimates for preparatory work, which if arranged for will in itself make for development along this line.

The foregoing paper by Mr. Muller was presented at the recent annual meeting of the American Road Builders' Association.

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# POWER PLANT PROGRESS DURING 1922

*By Prof. A. W. Cole, Purdue University, Lafayette, Ind.*

The effort to obtain supremacy in any line of business by concealing improvements in processes and equipment is now generally considered futile. Present day practice is frankly to discuss the problems and difficulties of each particular concern in order to reach a solution which will benefit all alike.

The past year has been one of continuous progress in the field of Power Plant Engineering. A brief discussion of this progress should be of great interest to all engineers interested either in the production or use of power from a Central Power Plant Organization. Let us first glance over the field of Prime Movers.

*Turbines*

No great or marked changes have been made in turbine construction. Much, however, has been done on details in an effort to increase efficiency and reliability. Refinements in materials and workmanship have continued to occupy much attention, and it is now recognized that

high efficiency depends largely upon improvements along these lines.

In Europe the trend in turbine design is toward higher speeds, higher superheats, and higher total temperatures.

*Emergency Governors*

It is now standard practice to equip old and new turbine machines with emergency governors set for 1 or 2 per cent over normal speed. The advantages of short range governors are apparent in case of system trouble. With the new governors the necessity of disconnecting the unit from the load and dropping the speed below normal or stopping before resetting the governor, is avoided. In the General Electric units of large size the emergency governor is arranged to control the main governor as well as the throttle.

*Turbine Wheels*

The General Electric Company has developed a system of tests by which turbine wheels can be vibrated by means of a solenoid or other external means. Wheels which are thus shown to be subject to certain kinds of vibrations at or near their normal speeds are considered dangerous, and their removal or rejection is therefore recommended.

*Turbine Generating Unit Performance*

In the U. S. an effort has been made to evolve a method whereby the performance of turbine generating units can be compared, irrespective of the service. A similar effort is being made abroad.

*Condensing Equipment*

The use of varnish to protect the entering ends of condenser tubes, or the insertion of liners or ferrules to take the wear, is being tried in many cases. The success of these devices is still to be proved.

*Circulating Water*

The concentration of impurities in the cooling water used in condensors, due to recirculation through spray ponds and cooling towers is often the cause of serious scale formation. To avoid this difficulty the circulating water is being treated chemically or Monel or bronze linings are being used in condensing equipment, to prevent corrosion.

*Cleaning of Condensers*

Considerable progress has been made of late in solving the problem of cleaning condensers, without removing the equipment from service.

Hydraulic jets are employed to free the condensers of matted material, but are not effective for removing slime and adhesive materials. The jets appear to be of greater value in horizontal than in vertical condensers.

Compartment condensers offer another solution for the problem. Their use allows a part of the apparatus to be cleaned at a time while the remainder is doing the work of the whole.

Tube cleaners are easy to operate, but are not always effective in removing slime. Compartment condensers permit complete cleaning. Which method will prove best in any given case depends upon the particular installation and the nature of the deposits.

*Expansion Joints and Condenser Supports*

Three kinds of joints between condenser and turbine are now employed, the rubber expansion joint, the sliding joint with mercury seal, and the packed sliding joint sealed with water.

Rubber joints are apt to give trouble if not carefully supported or if subjected to varying degrees of pressure. Where the latter condition prevails the joint should be supported by steel rings, one on the outside and one on the inside, to prevent breathing and cracking.

One large power company reports that mercury seals are difficult to maintain, owing to the fact that it is hard to get cast iron mercury-tight, because of the minor flaws that are apt to appear in the cast iron. Dust or dirt getting into the mercury seals also causes trouble.

Large condensers are so heavy that it is not possible to support their whole weight on the turbine outlet. A device has been perfected by which the condenser is weighed; the proportion of weight on the turbine is measured by using hydraulic jacks. Four jacks are used, each operated by a single hand pump and equipped with a gage. During the erection of the condenser and before bolting it to the turbine, jacks are placed under the spring supports; in this way the condenser is weighed empty. To this is added the calculated weight of the cooling water and thus the total weight is obtained. After bolting the condenser to the turbine, the jacks are adjusted to carry the proper spring weight; the spring supports are then blocked in this position. With this apparatus the checking up of the spring load may be accomplished at any time.

*Boilers, Superheaters and Economizers*

During the past year no boiler plants of unusual size or type or of widely different operating conditions have been installed. There is a continued tendency toward the use of higher boiler pressures

up to 350 lbs. gage and a superheat to a total steam temperature of 700 deg. F.

*Superheaters*

Research indicates that as boilers are installed with a larger ratio of combustion space to heating surface there will be less variation in superheat over a wide range of boiler capacity. Variation of superheat is dependent not only upon the ratio of superheater surface to boiler heating surface, but also upon its location with respect to the boiler heating surface, the action of the flame on the fuel bed, the kind of fuel burned, and the temperature of combustion.

On account of the increasing tendency to operate boilers at higher sustained ratings and to require as constant a superheat as possible, more attention must be paid to the baffling of boilers. Marked preference is being shown for the use of individual baffle walls, which permit gas passages to be arranged to suit the designer and the velocities of the flue gases.

*Soot Blowers*

The commercial value of mechanical soot blowers over the hand operated type has always been questioned. The problem, however, appears to be one of local conditions. If the size and height of the combustion chamber be increased, it is not improbable that soot blowing may be reduced to a minimum.

*Economizer*

Opinions differ greatly as to whether scrapers or mechanical blowers are more advantageous for cleaning soot from cast iron economizer tubes. The concensus of opinion seems to be strongly in favor of the use of mechanical soot blowers, rather than scrapers. The reason for this preference is that scrapers require a large number of holes in the top of the economizer, and these holes permit a large quantity of air to enter the casing, especially when induced draft is used for higher ratings. It is also felt that the scrapers by their ironing action pack onto the outer surfaces of the tubes a compacted deposit which forms a good heat insulator.

*Refractories for Stoker Furnaces*

A number of manufacturers are now offering a composite fire brick which is much more refractory than the earlier type made from fire clay alone. These bricks are usually produced by blending high grade fire clay, beauxite, and other ores having a high aluminum content. The capacity of fire clay bricks to support loads when exposed to high temperatures is now a serious limitation upon furnace temperatures. This limitation can be overcome by using higher grades of refractory material costing several times as much, or by reducing the temperature of the furnace walls relative to the temperature inside the furnace. This latter end may be accomplished by blowing air currents along the walls on the inside of the furnace, or by cooling the outside of the walls with water or air circulation, thus increasing the radiation through the brick and reducing the temperature.

*Preventing Clinker Adhesion to the Brick Work*

The most popular means of preventing clinkers from adhering to the brick work of furnaces is the use of perforated brick block along the clinker line. Through these perforated bricks air is blown from the stoker air ducts. The results have so far been satisfactory. Carborundum brick only gives good service with certain classes of coals.

*Stokers*

The tendency in stoker design is to refine the apparatus so that higher thermal efficiency will be secured. This practice has led to larger furnace volumes and larger stokers.

Chain grate stokers are now being adapted to the burning of coal under forced draft. Power agitators are being used in the fuel hoppers so that the fuel will feed uniformly.

A notable advance is to be observed in the more general adoption of the rotary ash-discharge type of stoker. This device permits the burning of a greater per cent of the carbon out of the coal and consequently less carbon appears in the refuse. It also results in a substantial labor saving. The refuse is discharged cold, and usually dry, which is likewise an advantage.

*Station Auxiliaries*

Reliability of operation in station auxiliaries is the great demand at the present time. Progress in the segregation of the control devices of auxiliaries has gone so far that in most cases the auxiliaries are now under the control of one man.

*Boiler Feed Pumps*

For purposes of reliability practically all boiler feed pumps are now turbine driven. A few electrically driven pumps have been installed. One company is using two sets of pumps with cast iron economizers. Low pressure pumps deliver to the economizer, and high pressure pumps deliver from economizer to boiler.

Installations are about evenly divided between single and double suction pumps.

*Forced Draft Fans*

The tendency is toward motor-driven forced draft fans. Practice is divided between individual fans for each boiler and a common duct with several large fans discharging into it. Even with individual fans it is the usual practice to have a connecting duct for emergency use. In some cases fans are being used as large as 250,000 cu. ft. per minute against 6 ins. of water.

*Coal and Ash Handling*

No change of any consequence has taken place during the past year. The use of hot tunnels for the thawing of coal is being abandoned because of the cost. Pneumatic chisels are being tried instead of the hot tunnels. Automatic coal samplers have not gained in favor. The disposal of ash by sluicing appears to be gaining slowly in popularity.

*Station Piping*

Pipe line welds as made a few years ago are proving dangerous. But welded pipe joints reinforced by sleeves are proving very satisfactory. In high pressure service steel body valves are being used with Monel metal parts in contact with the steam. Experiments are now being carried to secure better designed power-operated valves for emergency conditions, but no conclusions of value have yet been reached.

*Instruments*

Two new automatic CO2 recorders have been tried with success, checking within 1 per cent of the Orsat.

Trouble has been experienced with some of the multiple U-tube draft gages on account of the liquid leaking out and making frequent checking necessary.

Some attempts have been made to measure condenser leakage electrically. They have not been so successful as it was hoped they would be, because of the variation of soluble and suspended matter in the condenser cooling water.

*Ash-Pit Loss Records*

A recording gas-filled bulb thermometer has been devised for recording ash pit loss when traveling grates are used. The bulb extends nearly across the furnace and is located at the rear of the grates. It is exposed to the radiant heat of the material discharged from the rear of the grate. By proper calibration it is claimed that the temperature record can be made an index of the fuel rejected to the ash pit.

*Oil and Gas Engines*

During the year no important changes have been made in oil and gas engine design. A single cylinder engine with as high a rating as 2,000 h. p. has been reported. This seems to indicate that large powers may be safely developed in a single cylinder.

*High-Pressure Steam*

The average American practice favors 300 lbs. steam pressure and a total temperature of 650 deg. F. Several plants are now operating at 350 lbs. gage pressure and a temperature of 700 deg. F. Foreign practice tends to slightly higher pressures and temperatures. Germany offers an example of 900 lbs. gage pressure. It is a general practice for all auxiliaries to use the same pressure as the main power units.

*Station Buildings, Foundations and Sites*

The chief consideration in the location of a power plant is the cost of obtaining and carrying water and the cost of carrying away the output. The cooling water is the most bulky and is usually the determining factor.

Apparatus which needs frequent attention or which must be protected from the weather must be housed. There is a growing tendency to install as much apparatus as possible out of doors, especially high tension electrical apparatus, transformers, lightning arresters and switches; also water softeners, coal and ash bins, breechings, induced draft apparatus, and coal and ash handling equipment.

A laboratory, locker room and first aid room should be provided; adequate shower baths and toilet rooms should be considered a necessity. In many cases sleeping quarters, in addition to the regular equipment, are proving an advantage.

Location near a railroad is always an advantage. The heating and ventilation of the station should be carefully worked out in each case.

As a rule it is advisable to use reinforced or massed concrete for foundations rather than steel. This construction is much less expensive than steel, and much better.

Buildings constructed of concrete throughout are usually too costly to be practical. For this reason, steel brick and tile are entensively used. Tile floors while easily kept clean are expensive to

install and maintain. Concrete is generally accepted as the best floor for central stations.

The grounds around the station should be kept neat and attractive at all times. They should usually be surrounded by a good metal fence.

*Pulverized Fuel*

In cement mills, copper refining and allied processes, pulverized coal is now being used at the rate of about 13,000,000 tons per year. It is also becoming a real factor in the steam power plant field. Much work is now being done to develop efficiency in this direction.

*By-Products*

The extraction of by-products from coal may become profitable when the market value of these by-products is sufficient to offset the cost of processing. The chief product is either a solid fuel with low volatile content, resulting from low temperature gasification process. The by-products in both cases are tar, oil, ammonia, and the former process gaseous fuels.

*Burning Low-Grade Fuels*

During the past year no progress of importance has been made in burning Lignite and similar fuels.

*Oil, Gas and Liquid Fuels*

In the use of oil, gas, and liquid fuels no substantial advances have been made.

*Lubrication*

Lubrication is not at present satisfactory, owing both to the oil itself and the method of applying it. A committee is now at work trying to find means to remedy existing difficulties. Standard methods of testing as well as specifications for bearings and oils are being formulated.

The details of power plant progress during 1922, as thus summarized indicate a very substantial progress in Mechanical Engineering, which is encouraging to those of us who are interested in engineering education.

The foregoing paper by Prof. Cole was presented at the recent annual meeting of the Indiana Engineering Society.

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# IOWA PRACTICE IN PROGRESSIVE CONSTRUCTION OF HIGHWAYS

*By C. Coykendall, Assistant Chief Engineer, Iowa State Highway Commission, Ames, Ia.*

No single problem is provocative of more difference of opinion than that of the proper policy for the development of a highway transportation system. Nor is it surprising that such should be the case, for there is no one proper solution to the problem. Obviously, the proper solution of Rhode Island's highway problem will not apply equally well to the highway problems arising in Texas, nor can a solution that is proving effective in Pennsylvania be unqualifiedly recommended for Wyoming. The problems arising in connection with the building of a system of highways are manifold, and fortunate indeed is the state which has highway laws flexible enough to fit all conditions within the state, and officials in charge of highway work possessed of sufficient vision, courage and authority to apply the proper solution to the various problems confronting them. If such a state there be, let it be known, in order that the law makers and highway officials of other states may journey thence and become enlightened.

*Iowa's Road Problems*

Iowa's road building problems are not exactly duplicated elsewhere. The state has 56,000 square miles in area and more than 104,000 miles of rural highway, with practically every one of these miles, to a greater or less degree, an essential part of the state's highway transportation system. Every section of the state is productive, and consequently is inhabited. Excluding the population resident in cities and towns, it is found that the density of rural population is remarkably uniform throughout the state, with a correspondingly uniform need for a usable system of rural highways throughout the state.

*Nature of Traffic*

Let us consider for a moment the sources and kinds of traffic that the roads in Iowa are called upon to carry. The surplus products of all sections of the state must be hauled over rural highways to the shipping and market points, and from these same shipping and market points, coal, machinery, lumber and other materials and supplies must be hauled back to the farm. Heavy tractors for operating threshing machines, corn shellers and silo fillers must be able to move from farm to farm, and for this purpose substantial bridges are necessary. A constantly increasing percentage of the children of the state are being educated in modern, consolidated schools, and the school busses in which these children ride to and from school nine of every twelve months of the year, must have safe and usable roads and bridges over which to travel. In those sections of the state within a radius of 50 miles of great meat packing centers such as Souix City, Omaha and Nebraska City, it is found highly

economical to market livestock by truck instead of by train, as it is found that the increased transportation cost by truck haulage is much more than offset by the small shrinkage in weight of the livestock hauled by train. In the vicinity of all considerable centers of population, slow and costly railway and express service is being supplemented by motor transport. Two of the nation's best marked and most widely-known transcontinental highways, and many other important but less widely-known interstate highways, cross the state. Yearly the interstate traffic on these highways is increasing. Traffic counts taken during the past season at a point east of Ames, where for a short distance the Lincoln Highway and the Jefferson Highway use the same road, show that of a total average daily traffic amounting to 1,036 vehicles, 148 vehicles, or 14.3 per cent. of the total traffic, were motor cars with foreign licenses. And last, but by no means least, the five hundred thousand motor cars owned in Iowa are decidedly active organisms, penetrating every nook and corner of the state, on business or pleasure bent, and requiring roads—usable roads.

*If Roads Had Kept Pace With Traffic*

From the foregoing, it will be seen that the various classes of roads in Iowa are called upon to carry almost every known variety of modern highway traffic, and the suddenness with which most of this traffic has developed is the element that makes the problem of providing adequate highways so stupendous. If the development of highways in Iowa during the past decade was to have kept pace with the development of traffic using those highways, there should have been constructed during that time at least 2,500 miles of paved road, at least 25,000 miles of graveled or similarly surfaced roads, another 25,000 miles graded and drained, and the remaining mileage maintained in usable condition and safely bridged. Such a program of improvement would have cost approximately a half billion dollars, whereas the actual total highway expenditures during this period amounted to approximately $195,000,000, or 39 per cent. of what would have been necessary had highway improvements kept pace with the development of highway traffic.

*Investment in Motor Vehicles*

On the other hand, during the same period of time the people of Iowa have invested more than three-quarter billion dollars in automobiles, thus showing a much greater liberality in the financing of privately owned rolling stock than in the financing of publicly owned road beds.

*Conditions Prior to* 1904

In most respects the citizens of Iowa are conservative. Having no great centers of population, her policies as a state are formulated largely by the people of the rural communities—people whose personal prosperity has resulted from conservatism in their personal affairs and who naturally are wont to apply the same policies to public affairs. Logically enough, therefore, Iowa's highway policies have always been conservative. Until 1904, Iowa as a state took no part whatever in road building activities. All such work was under the supervision of county and township officials. Bridges of 16 ft. span or more were known as county bridges and were built and maintained by the county. In addition to this, county boards of supervisors had authority to levy a small tax, known as the county road tax, the proceeds from which could be spent on road work by the county supervisors at their own discretion as to location and type of improvement. As the condition of roads and bridges was a matter almost wholly of local concern, logically enough the administration of highway matters had remained vested in local officials.

*Drainage Structures First*

About twenty years ago, when it first began to occur to some of the more forward-looking that the existing method of handling matters pertaining to roads and bridges might not be all that could be desired, it was natural that bridges and culverts received first consideration. Travelers on the road at that time could usually choose favorable weather conditions for making their trips, but the bridges and culverts had to be crossed. Further, about this time the heavy steam tractor was coming into more general use and was playing more or less havoc with flimsy bridges. Naturally the owners of these tractors wanted better and safer bridges built, and these same owners, through their state threshermen's association, later proved to be one of the most effective agencies in securing progressive road legislation.

The State Highway Commission, created by legislative enactment in 1904, was vested with only advisory powers. Such counties as desired could avail themselves of the Commission's engineering services and advice, although there was nothing obligatory that such advice must be fol-

lowed. Accomplishments during the period that this system was effective—1904 to 1912 inclusive—were entirely along the line of progressive construction. A large number of counties commenced building bridges and culverts of permanent construction and cutting down hills and filling hollows adjacent thereto. Toward the close of this period the use of large blade graders drawn by gasoline tractors became quite general, resulting in the building of a considerable mileage of dirt roads to a natural grade, and to sections closely approaching present day standards. Very little surfacing work of any kind was undertaken except for short stretches of gravel surfacing here and there in progressive communities where an abundance of local gravel was available.

*Legislation of* 1913

In the spring of 1913, radical highway legislation was enacted by the state legislature, which resulted in a complete change in the method of handling highway work. This legislation reorganized the State Highway Commission, clothing it with drastic supervisory powers, and providing adequate funds for its support. Under this statute the state continued its policy of non-participation in the cost of road building, but required all highway construction work, both road and bridge, to be done in accordance with plans and specifications either prepared by or approved by the State Highway Commission. Other outstanding features of this legislation were the requiring of each county to employ a county engineer to supervise road and bridge construction work, and the classification of highways into a county system and a township system, the former being placed entirely under the supervision of county officials, and the latter remaining under the jurisdiction of township officials, with the restriction that any construction work upon the township road system must be done in accordance with plans prepared by the county engineer and approved by the State Highway Commission.

*Some Real Strides Made*

Under this scheme of operation, real strides were made in the way of progressive road construction, particularly upon the county road system. By the end of 1916, approximately 1,600 miles had been built to established grade in accordance with approved plans; approximately 25,000 bridges and culverts had been constructed of so-called permanent construction; practically the entire mileage of the county road system—some 15,000 miles in all—had been constructed to natural grade and standard section and was being rather systematically maintained; in fact, Iowa had acquired a reputation for having a remarkable system of dirt roads—remarkably good under favorable weather conditions and remarkably muddy during rainy weather. Still but little surfacing work had been undertaken, road building efforts and revenues as yet being devoted to the building of earth roads and substantial bridges and culverts, with here and there a few rather desultory attempts at gravel surfacing.

*Federal Aid*

The coming of Federal participation in highway building necessitated further changes in Iowa's highway laws. Such changes were brought about during the legislative sessions of 1917 and 1919. A further classification of highways was made, a limited trunk line system of approximately 6,600 miles being designated as the Primary Road System, upon which all Federal Aid allotted to the state, as well as all revenues derived from the licensing of motor vehicles, must be expended. The remaining mileage of highways was classified as secondary roads, approximately 11,000 miles of which constitute the county road system, and the remaining 87,000 miles still being under the supervision of the township officials.

*The Primary Road Fund*

Under this revised legislation the policy of progressive construction persists. The Primary Road Fund—Federal Aid and revenues derived from the licensing of motor vehicles—is divided among the various counties of the state in proportion to their area, providing a fund of approximately $90,000 annually to the average county for improving and maintaining approximately 67 miles of primary road. Obviously this fund is not sufficient to make possible any considerable progress in building roads having a high type of surfacing, and except in those few counties that have taken advantage of a provision of the law which allows anticipation of future allotments of Primary Road funds through the issuance of county bonds, the improvements undertaken on the primary road system consist largely of completing the construction of roads to established grade, providing the necessary drainage and drainage structures, and when this has been completed, surfacing with gravel or sand-clay construction. In addition to the inadequacy of funds heretofore mentioned as restrictive to a pav-

ing program, the law imposes further restrictions in requiring the question as to whether or not the primary roads of a county shall be hard surfaced to be submitted to a vote of the people of the county. The further provision that when hard surfacing is authorized, 25 per cent. of the cost thereof is assessed to abutting and adjacent property, acts as an additional deterrent in getting a hard surfacing program under way.

*Progressive Construction*

Accomplishments toward the improvement of the primary road system since its establishment are therefore largely along the line of progressive construction. On Dec. 1, 1922, of the 3,653.5 miles of the primary road system that had been constructed to established grade and the necessary drainage and drainage structures provided, 334.4 miles had been paved and 1,558 miles had been gravel surfaced, leaving 1,761.1 miles without surfacing of any kind. A large percentage of the mileage that has been gravel surfaced will need to be paved some time within the next decade if traffic is to be adequately served. In the meantime, however, traffic on these 1,558 miles of gravel surfaced highways is getting reasonably efficient highway service, whereas the same funds invested in pavement would have given traffic a high grade of highway service on only approximately 150 miles.

It will thus be seen that up to the present time road building in Iowa has been hedged about with restrictions that make any policy other than that of progressive construction, entirely immpracticable. Neither is it believed that Iowa is the loser on that account, nor that the opposite policy of highway improvement, that is, the concentration of available highway revenues upon a limited mileage of high type roads, would have given traffic upon the highways in Iowa a service comparable to the service that has been given. The dirt roads that have been constructed to established grade and the necessary drainage and drainage structures provided, give vastly better service than do the ungraded, undrained, and poorly bridged highways. Also, the highway that has been graded several years in advance of the time that it is to be hard surfaced is in much better condition for hard surfacing than is a newly graded highway, particularly so in locations where the topography is rolling. To hold to 6 per cent. maximum grades on some primary roads in Iowa requires upward of 30,000 cu. yds. of earthwork per mile. Experience teaches that the resulting fills under these conditions require two or three years to become stabilized and that a rigid type of surfacing should not be attempted on these fills until they have become thoroughly stabilized.

In conclusion, it may be said that the policy of progressive construction of highways in Iowa is a logical result of its traffic needs and its highway laws, which after all are in a measure reflective of traffic needs. Under this policy, substantial progress has been made. If highway traffic is to be given anything like the service it deserves, however, there must be no undue hesitation about taking the succeeding steps so necessary to the success of such a policy. Based on present costs, at least one hundred million dollars must be spent during the next five years on constructing and maintaining the primary road system alone, if traffic is to be only reasonably well served. An equally large expenditure should be made during that period on secondary highways. It is not a case of the state not being able to afford such expenditures; rather it is a case of the state not being able to afford to do without the highway service that will result from such expenditures.

The foregoing paper was presented by Mr. Coykendall before the recent annual meeting of the American Road Builders' Association.

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## WHY MT. PLEASANT, MICH., PAID $39,750 FOR A $15,000 WATER IMPROVEMENT

*By C. H. Peterson, City Manager, Mount Pleasant, Mich.*

The $15,000 water improvement bond issued in 1892 cost the city of Mt. Pleasant $39,750.

This is a condition that one might find, upon close examination, has existed in a good many other cities in the United States. Long term bonds have been quite generally used in the past, but modern methods of city finance have diverted to serial bonds and a great number of cities have gone so far as to provide in their charter that all bonds issued shall be serial bonds.

The water department of the City of Mt. Pleasant is municipally owned. In 1892 it was not on a paying basis, so the city issued a $15,000 long term improvement bond to run for a period of 15 years at a rate of 5 per cent. During these 15

years, there was no money set aside in a sinking fund to pay for this bond when it became due in 1907. It seemed that each council that was in power during that time did not know of this bond or else they wanted to keep the tax rate down during the term of office, so, when the 15 years were up and the bond was due, there was no money available to retire this bond unless the council should put an additional amount in the taxes that year and raise the whole $15,000 in one year. This would seem a disaster to the taxpayers to have this additional amount to pay in one year when they were only raising $17,400 in taxes for that particular year to carry on the expenses of the City. This would make the rate for that year $18.20 per $1,000 instead of what it originally was, $9.80 per $1,000. We all know very well what the sentiment of the taxpayers would be if any council should raise the tax rate about double over the previous year. So the only resort that the governing body could revert to was to refund, which they did.

This $15,000 bond was refunded for a 4½% rate and I compliment the council for getting the interest rate lower, but it was refunded on a long term basis for 20 more years instead of making it a serial bond, this bond maturing in 1927. Again the same mistake was made.

Not a cent was put into a sinking fund to relieve this bond until June, 1922, when $2,500 was appropriated by the commission, and it was recommended that the same amount should be appropriated each year for the next five years, making a total of $15,000 to retire this bond on July 15, 1927.

The following will sum up the cost of the $15,000 water improvement. Interest on the first bond for a period of 15 years at 5 per cent is $11,250. Interest on the second bond for a period of 20 years at 4½ per cent is $13,500, making the total interest paid $24,750, plus the bond itself, or $39,750. If this bond had been made a serial bond at 5 per cent for a period of 15 years, we would have paid $6,000, plus the bond, or $21,000, making a saving of the difference between $39,750 and $21,000, or $18,750.

In other words, if this bond had been a serial bond, the taxpayers would have saved enough to pay the taxes for the year of 1907.

This particular bond is only one of several such bonds that this City has had to shoulder. We are now paying the City debts that should have been paid 15 years ago. No wonder that taxes are high.

Again I say, "Let us pay as we go and relieve ourselves of that burdensome interest. Pay for what we get when we get it and do not pass it on to George."

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## NEW HIGHWAY BRIDGES TO CROSS MISSOURI RIVER

*By B. H. Piepmeier, Chief Engineer, Missouri Highway Commission, Jefferson City, Mo.*

For many years Missouri has lacked adequate facilities for highway crossings of the Missouri River. This has been a serious impediment to commercial and social intercourse between the two sections of the state. The three existing highway bridges at Kansas City, Jefferson City and St. Charles are too widely separated to give the needed service and are, moreover, toll bridges.

However, this unsatisfactory condition is about to be remedied. The prospect of securing a state road system has stimulated new activity in the promotion of several bridge projects that have remained in a dormant stage for a number of years.

The State Highway Commission has very properly recognized the need for these lines of communication between the two sections of the state and has recently approved four projects for highway crossings and allotted Federal Aid money to them.

These projected bridges are to be constructed at Boonville, Glasgow, Waverly and Lexington. All are now under contract and the substructure work of the Boonville bridge is well under way. All are high level bridges with sufficient clearance above standard high water to render unnecessary any type of movable spans.

The Boonville bridge will have a steel superstructure 2,665 ft. long and a substructure of concrete piers resting upon bed rock, the lowest elevation of which is 84 ft. below standard low water. A reinforced concrete trestle approach 447 ft. long connects the main structure with an earth fill confined between long wings of a U abutment for 117 ft. At the north end of the bridge is another earth fill approach 442 ft. long. A clear roadway of 18 ft. 8 ins. is provided. The estimated cost of this structure is $526,640. Consulting Engineers are Harrington, Howard and Ash.

The Glasgow bridge consists of four river spans, approximately 1,224 ft. total

length. The approach at the Glasgow end is nearly 300 ft. long and is composed of three deck spans. An earth fill 225 ft. long connects the approach with the city. For the west approach, four deck spans totaling 384 ft. are provided. An earth fill approximately 440 ft. long connects the approach with the mainland. The river piers rest upon bed rock about 38 ft. below standard low water at the deepest place. A clear roadway of 21 ft. is provided. The contract price for this structure is $566,312.50. Consulting Engineer F. W. Adgate.

The bridge at Waverly consists of five river spans, having a combined length of nearly 1,610 ft. Piers are sunk to bed rock about 53 ft. below standard low water. The approach at the Waverly end is made up of one deck truss span and two deck girder spans having a total length of 345 ft. A short earth fill connects the approach with the streets of Waverly. At the north end an earth fill terminates the bridge. A roadway of 20 ft. between wheel guards is provided. The contract price is $585,146.32. Consulting Engineers, Harrington, Howard and Ash.

The Lexington bridge has a steel superstructure 3,071 ft. in length. Bed rock is approximately 100 ft. below low water. On the Ray County side, an earth fill connects the main structure with the mainland. On the Lexington side the main structure is connected by a steel trestle with the city streets. A roadway 20 ft. in the clear is provided. Contract price is $1,169,114.10. The additional length of superstructure and the greater depth to bed rock explains this greater cost. J. A. L. Waddell is the Consulting Engineer.

The completion of these four large bridges will go far towards giving Missouri a basis for a comprehensive road system connecting all parts of the state.

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## TESTING FLOW OF WATER IN GRAVEL STRATA AT SOUTH BEND, IND.

To the Editor:

In connection with the engineering investigations incident to the development of the water supply for a water works pumping station having an ultimate capacity of 25,000,000 gals. daily, which I now have under design for the City of South Bend, Indiana, I have concluded a test determining the direction and rate of flow in the gravel strata that may be of interest to your readers.

In order that you may more readily grasp the necessity for making the test, and the significance of the results, a brief review of the growth of the South Bend Water Utility is necessary.

The original system was built in 1873 using as its only source of supply the St. Joseph river and it was not until 1880 that any other supply was available.

In 1880, ten 6-in. wells were sunk to a gravel strata approximately 100 ft. below the surface, and subsequently additional wells were drilled in 1895. The entire supply was from this source with no connection for pumping from the river. This was done with no special investigation as to the source of supply, the assumption being that the underground storage was either seepage from the river or the result of percolation from precipitation on a rather restricted area as indicated by the topography in the immediate vicinity of South Bend.

This assumption was satisfactory and computations indicated a sufficient supply for the comparatively light requirements of a small water utility.

The growth of the city has been such that future development demanded a more specific knowledge of the source and extent of the underground water supply, and for this purpose the test was conducted.

A study was made of the direction and density of growth, and the incident extensions to the distribution system to determine the most economical location for the construction of a station. This was followed by test borings to ascertain the grading of the gravel in the water bearing strata.

Following the location of a desirable water bearing gravel, a 12-in. well was drilled to a depth of 155 ft. and this well surrounded by 2½-in. wells at a radius of 6 ft. from the central well and to the same depth; the central well was charged with salt and Basic Fuchsin, and each of the surrounding wells equipped with an electro couple connected through a sensitive ammeter to the 110-volt lighting circuit. Hourly readings were taken through the electro couple on all of the wells and, to insure the sampling of the vein one gallon of water was pumped from each well hourly and examined, by comparison with the original samples, for traces of color.

The time required for the flow of 6 ft. was 82 hours, as evidenced by the reduction of resistance in the electric circuit and the positive color traces in the sam-

ples pumped. The direction of flow is slightly north of true northwest.

While the result of this test is not conclusive, it is confirmatory to my belief that the underground water supply enjoyed by the City of South Bend is not in any sense local in character, but is derived from a water shed extending up from Lake Michigan and Lake Erie to a summit approximately at the Indiana-Ohio State Line.

This belief is further confirmed by the logs of a number of wells with which I have come in contact in my engineering work in this territory in the past 15 years.

Very truly yours,

JOHN W. TOYNE,

Consulting Engineer and Superintendent of Water Works, South Bend, Ind., Jan. 16, 1923.

## ST. LOUIS PAVING PROGRAM

The City of St. Louis has adopted a program for municipal paving for 1923, amounting to approximately six million dollars. Like most American cities, the St. Louis paving fell far behind the demand during the war period and the years immediately succeeding. The street paving itself dropped down to an average of approximately 12 miles a year for 4 years. While this to some extent has been made up in the work of the last two years, the condition is still far from satisfactory. The program for 1922 amounted to two and a half million dollars, but on account of the strike situation approximately one-third remains uncompleted. The program for this year of six million dollars will be more than one hundred per cent increase over last year, and about five hundred per cent of the average work for several years preceding.

All of this work is paid for in special tax bills, which requires that the contractor must finance the work until completion, and then take payment in tax bills bearing six per cent interest. These bills are first lien on the property. This tax bill provision has apparently prevented small outside contractors from coming in on St. Louis work during the period of expanding business, and may make it difficult satisfactorily to place the business proposed for this year.

In addition to this program of special tax work, which will probably be continued for several years to come, St. Louis voted the issuance of bonds on Feb. 9th, which included among numerous items, about five million for cash payment paving work, and about nineteen million for sewers and related construction. Mr. W. W. Horner is Chief Engineer of Sewers and Paving.

## COST OF PAVEMENT REPAIRS IN NEWARK, NEW JERSEY

*By J. W. Howard, C. E., Consulting Engineer, 234 Mt. Prospect Ave., Newark, N. J.*

Newark, New Jersey, is a manufacturing city of 500,000 population. It has heavy traffic of motor vehicles not only within it but connecting it with New York, Philadelphia, etc.

The streets are well paved and kept in good repair. The cost of repaving or maintaining each kind of pavement is analyzed and tabulated so as eventually to determine what kinds of pavements are most economical.

The annual report for 1921 of the Director of Public Improvements shows the cost of repairs per square yard of pavement bases and of surface layers, separately and added together.

The total paved streets on December 31, 1921, was 282 miles. The principal kinds of pavements are shown in the table below.

The city has an excellent municipal asphalt pavement plant equipped with storage bins, conveyors, steam rollers and street tools. This plant cost $76,355, not including the land. This plant repairs all old asphalt pavements and lays some new ones on new locations. The cost of repairs made by the City plant in 1921 to the pavements which have passed the five-year guaranteed periods of the original contractors is shown in the following table:

COST OF 1921 PAVEMENT REPAIRS BY NEWARK, N. J., CITY ASPHALT (ETC.) PLANT

| Kind of Pavement. | Surface Layer Sq. Yds. | Surface Layer Per Sq. Yd. | Concrete Base Sq. Yds. | Concrete Base Per Sq. Yd. | Total Both* |
|---|---|---|---|---|---|
| Sheet Asphalt | 51,499 | $1.8126 | 3,979 | $2.3313 | $4.1439 |
| Granite Block | 27,815 | 1.5262 | 1,131 | 2.6651 | 4.1913 |
| Brick | 6,679 | 3.4968 | 3,236 | 4.1820 | 7.6788 |
| Asphalt Block | 126 | 4.2169 | 59 | 2.9908 | 7.2077 |
| Wood Block | 4,168 | 4.4164 | 3,487 | 1.5341(v) | 5.9505 |

*Total Both—means where surface and base were repaired at same locations.
(v) Repairs to base of wood block pavement consisted of replacing injured 1 in. mortar cushion with another on the existing good 6 or 8 in. concrete base below.

# Construction News and Equipment

## HEAVY TRUCK HAULAGE ON HIGHWAY CONSTRUCTION

*By Charles H. Fry, President Chas. H. Fry Construction Co., Erie, Pa.*

The title of this paper implies a certain preference for heavy duty trucks for haulage purposes in connection with highway construction, particularly when presented by an author whose experience has led him into favoritism for this type of hauling equipment.

Although several standard methods have gained preference among various highway constructors in various sections of the country, we are allowed to assume that the road constructors and the equipment manufacturers and distributors are all determined upon one definite objective, i. e., in his estimation, have governed his management in the selection of the heavy duty truck for haulage. The author confines production progress with the least necessitated amount of waste, i. e., waste capital (investment) waste labor, waste material, waste efficiency, waste what not.

In the last analysis, we aim for the minimum cost per unit of laid concrete, excavated or filled earth or rock.

The proposition which concerns the contractor in his everyday experience with the trade, is what method attains the common objective and proves itself superior over all other methods? This is a question not easily answered.

Therefore, in the presentation of this paper, the author desires to draw attention to those determining factors, which, himself to a discussion of haulage equipment serving in the construction of macadam, gravel, "stone" and concrete roads.

*Variety of Roads*

The natural sand-gravel roads such as as abound on and near those flat plateaus surrounding and adjacent to the Great Lakes, as well as similar natural roads found in other sections of our country, also the rock formation forming the sub-base for so many of the roads in the mountainous districts of the United States, without a doubt, serve best for permitting the utilization of the heavy duty truck. This type of sub-base permits the early escape of water from rainfall and consequently discourages layup of heavy duty trucks at times when saturated clay and muddy roads would necessitate costly loss of time from continuous operation. Such a factor has contributed toward making the author a heavy duty truck enthusiast when possibly a highway contractor in some other section of the country would favor a different method.

One point to consider in this connection is: in how large an area of our country can the heavy truck be utilized to distinctive advantage? The factors to be considered in this paper point the way to a comprehensive survey. Recent charts compiled and edited by the Associated General Contractors of America, showing the seasons of the year suitable for road construction purposes in the various States of the Union, will serve as a guide in reaching a conclusion.

*Hauls*

Closely related to the foregoing and hardly less important is the subject of hauls. Obviously the only ones to be considered are short and long hauls. Other things being equal, the advantage is constantly growing in favor of heavy duty trucks because of the increasing tendency toward longer hauls on contracts being let by State Highway Departments.

The long haul utilizing heavy trucks reduces the amount of field supervision, such as is necessitated when fleets of small trucks are on the road. One striking advantage in operating fewer units is the obvious absence of contributing causes toward units getting in the way of one another. Simple though it may seem, this is a very important consideration in the hills and in the mountainous country removed from the Lake Region and the flat country of the Middle West. The long haul manifests the advisability of heavy units, particularly when taking into consideration the availability of experienced and dependable labor.

*Co-ordination*

We cannot intelligently discuss haulage characteristics and requirements without taking fully under advisement the correlated equipment and special appliances which are utilized in the other operations.

Like all industries, which, in their pioneer days, were hampered and delayed from time to time because of inadequate facilities and lack of improved equipment, so was the road construction industry handicapped in its early days. Of late years, however, the industry has been the beneficiary of many improved types of equipment, so that instead of becoming impoverished because of neglect or indifference, we find ourselves today reinforced along every avenue of exertion by improved and, in numerous instances, highly developed and patented road building appliances. These have been devised to ameliorate the obstacles long contended with.

The equipment manufacturers have proven themselves practical students of a stupendous industry as is testified to by the numerous dependable types of labor saving road construction equipment now on the market.

We have both ends of the haul to consider, not ignoring the requirements that demand attention between the two extreme points of operation. Between the measuring and striking off points and the unloading point at the paver skip, the heavy duty truck stands as a supreme testimony of efficiency. As the old adage goes—"An early start is half the race."

Gliding into position under an improved and latest design measuring and striking off hopper, a heavy duty truck stops for the fractional part of a minute, swallows its load of four standard six bag batches of aggregate and is off on the last leg of the journey in no more time than is required to do the same thing with the one batch only on a light truck.

And when the big truck arrives at its destination, backing into the paver, the fewer the trucks, the less the disturbance along the way and at the paver itself.

*Maintenance*

Without entering into an analysis of pure cost data or summarizing along this particular line, there are outstanding merits in favor of heavy trucks along lines of pure operation and maintenance.

The restricted labor supply of the past warrants the conclusion, comparatively speaking, that a few dependable and seasoned truck drivers of known qualifications form an operating force far superior to a larger force of doubtful personnel.

The trained driver on the big truck, educated to maintain his unit and to take pride in its performance is an asset to your organization and a factor to be considered in getting the unit of pavement laid at the minimum of cost. The maxim is efficient drivers and maintenance men, and they are ordinarily few, particularly when labor is at a premium.

In this connection, it is known that heavy trucks are slower than light trucks, nevertheless, there is apparently an advantage in wear and tear. It appears that the heavy truck stands the vicissitudes of operation to more marked advantage—the rugged frames, the heavy wheels, the big tires, the staunch bodies, as well as the enlarged members of motor, driving and transmission machinery, the ability to take punishment, seem to stand the gaff are readily amenable to satisfactory overhaul.

The great, strong, dependable units take their place admirably in helping to weave the cloth of progress.

*Flexibility*

When the contractor finds himself in the market for the purchase of transportation equipment, without a doubt he finds himself dealing with the most complex problem of road building. To arrive at any decision he must consider so many details that in the end he generally feels that he has reached only the experimental stage. There is a constant and inviting incentive to attain the best results. In touching some of the major problems consider first the investment. The expenditures for any type of hauling equipment is the largest item of the contractor's plant. This fact alone should cause the contractor to choose the most flexible equipment.

In the selection of motor haul equipment the road constructor must be governed by the various requirements which will manifest themselves from time to time during the progress of his management.

When he considers that he will be forced from time to time into competitive bidding upon all kinds of road contracts presenting multifarious conditions, the contractor, of necessity, must plan upon a suitable degree of flexibility. Heavy duty trucks provide for this flexibility that cannot always be provided for under other methods.

*Other Determining Factors*

Heavy trucks provide general adaptability. Even in seemingly unimportant ways, they are adaptable. In storage alone they require less space during layup and during idle time. Innumerable times they serve to manifest an indisputable advantage in towing other types of equipment. They augment the facility with which the general equipment is

moved on and off the job. In the matter of grades, experience has proven that the heavy unit will pull up and take any grade that the light unit can negotiate.

In the matter of sub-base, the greatest argument against heavy trucks seems to have been accusation that the sub-base was subject to an excessive amount of cutting up; but experience substantiates the contention that when sub-base conditions are at all favorable, the big trucks with their wide tires iron out the sub-base and pack it down like a roller. From the standpoint of public interest this provides a more substantial job.

*Conclusion*

In summarizing the elements of this paper, the author, with the brief amount of time available and naturally forced to the employment of general statements, has endeavored to point out the main factors which through analysis have placed him in the position of a heavy truck enthusiast.

He has been favored with the privilege and opportunity to operate and study different haulage methods, more or less of the time, of course, in a locality and at seasons of the year well adapted for the utilization of heavy units. And he has no argument with other contractors who may have a cherished method altogether different which may be entirely laudable and entirely adequate for the conditions encountered.

As far as truck haulage is concerned some contractors conclude that it is fitting to hire their hauling equipment instead of owning and operating it outright, and in this connection one has to consider that the number of dependable trucks available whose owners are willing to operate at a figure satisfactory to the contractor, enforces a determination of the rate of progress of the work under way.

And after all methods have been analyzed, the pros and cons discussed, the weak and the strong points compared, the legitimate contractor is brought face to face with a recognition of the merits of vision and the benefits of far sighted management. He must realize that no method, however good, will attain the objective unless there lies within his organization the common desire to function to the best advantage, unless throughout the organization from president to waterboy there is imbedded the keen desire to see the organization put the job across in the best possible manner to the best advantage of all concerned.

The foregoing paper by Mr. Fry was presented at the recent annual convention of the American Road Builders' Association.

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## IDEAL SECTION OF LINCOLN HIGHWAY BUILT AT MODERATE COST

With the completion of the paving of the "Ideal Section," a model stretch of road built in Northern Indiana by the Lincoln Highway Association with funds contributed by the United States Rubber Company, nation-wide attention has been focused on the road. A vast amount of discussion upon highway design and specifications has been stimulated. This was one of the aims of the Lincoln Highway Association in building the Section.

The Association has long felt that more public thought should be given to the nature of the improvements resulting from the investment of the hundreds of millions of dollars now going into highway construction in this country annually. According to officials of thet Association, the American public, which in the loing run is paying the bills, has not taken sufficient interest in the adequacy and performtance of the highways being constructed. Too frequently public ignorance of the problems confronting highway engineers and commissioners has resulted in mistaken public pressure for road improvement which was not properly designed to carry the traffic it would receive. The result has been inefficiency and waste.

*Public Understanding of Road Problems Required*

Highway engineers and commissioners in many sections of the union have not had the support of the public in undertaking farseeing improvement plans which, while seemingly expensive, would ultimately save the public large sums in maintenance and reconstruction costs and in facilitating travel.

A. F. Bement, Vice-President of the Lincoln Highway Association, in a recent address said: "The Association is gratified that such great public interest has centered on its short section of model road, designed by the foremost highway engineers and other authorities in the union. It is anxious that that project shall be well and correctly understood.

"The press in some sections of the country has, we believe, presented an exaggerated picture in regard to the cost of the improvement. The fact is, economy, not in first cost, but in ultimate cost,

was always before the technical committee appointed by the Association to design the Ideal Section for the traffic of today and tomorrow. The hard-headed men who determined upon the plans for the road, which it was hoped would serve as a model for many years, had no intention of being impractical or extravagant. Many of them were public officials, having in charge the expenditures of millions of the public's funds for road-building. They did not advise the Association to attempt any construction which could not be economically justified."

*The Cost of the "Ideal Section."*

The Association states that in some way the impression has gained currency that the Ideal Section cost $100,000 a mile. This is not the case. The cost of the reinforced pavement, which by the public is generally considered as the "road," was but $64,897.20 per mile. This for 40 ft. of concrete, 10 ins. thick and reinforced with 80 lbs. of steel to the 100 sq. ft. It will be noted that for the ordinary 20 ft. width, this road would have cost but $32,450 a mile, even though it was much more heavily reinforced and 2 to 3 in. thicker than the paving now being generally laid in many sections of the country.

Two bridges were included in the Ideal Section link and these two structures cost a total of $23,174.26. These expenditures are by no means extravagant. They represent true economy for the volume and type of travel the Ideal Section of the Lincoln Highway was designed to carry.

Additional funds, of course, were spent by the Association in the development of the design, and in the carrying out of the many added features recommended by the technical committee. The cost of the landscape work, which involved much preliminary planning it would not be necessary to duplicate if 100 miles instead of one were beautified, was $4,800 per mile, while the cost of illuminating the Section for night travel was but $4.051 per mile. In handling a project of this character money was necessarily expended on expert engineering consultation and in the infinite amount of red tape required to perfect the arrangements with the Federal Government, the State, and the County and the property owners. The benefits of these expenditures are available to any community in the country in the shape of detailed specifications and plans which may be had upon application without expense.

*Adequate Width and Strength True Economy*

Considering the economy of the Ideal Section's design for heavy volumes of traffic, it should be remembered that maintenance cost will be practically nil for many years, while the original improvement will carry the increasing traffic of the next 10 to 20 years without reconstruction.

The cost of a mile of road cannot be standardized. The sum justifiably to be spent in proper improvement varies with every changing location and condition. The State of New York has just finished the construction of four miles of road along the west bank of the Hudson River, between West Point and Cornwall, known as the "Storm King Highway" after six years of the most difficult work and at an expense of $700,000, or a cost of $175,000 per mile. The need for this road more than justified the expense.

The State of New Jersey has expended over $80,000 per mile on the construction of certain sections of the Lincoln Highway. Unless the conditions are fully known, no one can say whether this sum represents the truest form of economy or the utmost extravagance. The Lincoln Highway in New Jersey carries, in addition to the heavy volume of local traffic, the ponderous trucks operating out of Baltimore, Philadelphia, New York and Boston, and the through traffic from the South and West, reaching New York from Philadelphia. The old pavement, which was replaced by the New Jersey State Highway Department, consisted of a reconstructed macadam base, with a 2 in. bituminous surface. It provided for two lanes of traffic on a paved width of 18 ft. This section was built in 1915 and the repairs due to the heavy traffic cost the State $14,250 a mile, during 1920. New Jersey did a wise thing to tear out this old road and build a modern highway, providing for four traffic lanes, with a paved width of 32 ft. and a graded width of 40 ft. and 9 ins. of Portland cement concrete.

The Ideal Section was designed to carry a traffic of 20,000 vehicles per 24 hours and it can do so with safety, convenience and economy. The Lincoln Highway Association is anxious that the general public appreciate the careful thought and consideration given to the question of cost in connection with the construction of its model section, which without doubt will some day be continuous from Chicago to New York—as a matter of economy.

# REPAIRING A SMALL BRICK SEWER BY CEMENT GUN METHOD

*By R. A. Mac Gregor, Assistant Engineer, Department of Public Works, Borough of Manhattan, Municipal Bldg., New York, N. Y.*

It was found that the 3ft. 6 in. x 2 ft. 4 in. brick sewer in 41st Street between Madison Avenue and 5th Avenue, Borough of Manhattan, New York City, was in serious need of repair. Considerable areas of the first ring of the crown had fallen in and at one or more places both rings had fallen in. The joints were badly washed out, most of them for 2 ins. or more.

The use of the Cement Gun was considered for this job and decided upon after careful survey had been made and an estimate prepared of the cost of repairing by opening up the street for about 140 ft. and making other repairs from the inside. This estimate amounted to $2,845.

A cement gun outfit with two operators were hired through the Cement Gun Company, the city supplying all materials, gasoline and labor, other than the operators.

The first operation was to remove any loose bricks in the crown and to attach expanded metal to any areas of more than about 2 ft. square where the first ring had fallen in. This was done with 1-2 in. lag bolts or wood screws and the slight irregularities of the brickwork kept the expanded metal away from the bricks sufficiently to allow the gunite to reach behind the metal.

The first sections of the work were cleaned with a sand blast without water, but it was found that water alone cleaned the surface quite well with the advantage of leaving no sediment to be taken out of the sewer.

This sewer happened to be a clean one, with very small flow so that the sides and crown were not greasy. In most cases the sand blast would probably be needed to insure a good bond between brick and gunite.

The small size of the sewer, only 3 ft. 6 ins. high, made work difficult. As the nozzle could not be held far enough away the gunite did not spread as much as usual and a rougher surface was left.

From the spring line down, therefore, the surface was trowelled with a plasterer's trowel and a surface at least as smooth as good brickwork was easily obtained.

A coat of about 1 1-2 in. thickness was first applied over the expanded metal and left over night, and next day about 1 in. more was added. This gave about 2 1-2 in. of gunite in place of a 4 in. ring of brick, but in addition all joints in the second ring were thoroughly filled with gunite.

At one place a boulder about 12 in. in diameter had penetrated the second ring and earth was showing around it. Gunite was carefully applied here and left overnight and next day more was applied making at least 3 ins. of good concrete.

The entire interior surface down to the water line was coated with about 3-4 in. of gunite, this also filling all the joints as no hand pointing could do.

With an air pressure of 60 lbs. as commonly used, about 30 per cent of the sand was lost as rebound and had to be taken out before night as sufficient cement was carried in it to make it troublesome to remove in the morning. It was found that 30 lbs. of air pressure was sufficient to carry the sand the distance required and that with this reduced pressure only about 15 per cent of sand was lost.

The sand was well graded, practically all passing a 10 mesh screen and was carefully measured in a box for a 1 to 3 mix.

The cement was added making 9 cu. ft. of sand and 3 bags of cement, the whole turned over with shovels once and then put through a ¼-in. screen to prevent any larger balls of cement reaching the gun. This mixing and screening was done close to the gun to save labor in charging the same. After a rain the sand was rather wet, but a damp sand is to be preferred as the cement then adheres to it while passing through the hose.

A total length of 300 ft. of sewer was relined, 400 sq. ft. of expanded metal were used where the first ring had fallen in, and the time actually worked by the gun outfit was 11 days. The city gang was longer on the job as the gun outfit had to be taken away in the meantime for another job and then returned.

The entire cost to the city including hire of gun outfit, all materials and labor, hauling materials and removing waste and debris was $1,830, over $1,000 less than the estimate for work done in the ordinary way. Had the outfit been owned by by the city a greater saving would have been shown as there were unavoidable delays in getting the gun delivered twice, in breaking in the gang to new work, etc.

This work was done in September, 1921, under the supervision of the writer.

A careful inspection was made of the sewer in December, 1922, by the writer and another engineer. After more than a year not a single defective spot was found, no cracks were visible and under the hammer the lining rang hard and sound. Practically a new sewer has been secured.

In larger sewers the work would be done more comfortably and cheaply and this sewer is about the smallest size in which such work is possible.

## HOW TO DYNAMITE ICE GORGES

Damage, amounting in the aggregate to millions of dollars, is often caused at this time of the year by floods and freshets, due to ice gorges and ice jams in rivers and streams. At times these gorges so choke running streams that serious damage is done to bridge piers, bridges, dams, and other obstructions. Frequently also they cause water to back up, inundating adjacent country so that damage, inconvenience and sometimes loss of life is caused.

It is possible in many instances to obviate all danger by using dynamite to break up the ice gorges. When explosives are used for this purpose, the blasts should be directed at the key or pivotal points of the gorge. Two general methods of loading are practical:

(1) Holes are cut through the ice at spacings of from 8 to 10 ft. and the charges, the quantity of which must be governed by the thickness of the ice, thrust through the holes and allowed to be carried under the ice a little way from the holes. Such blasts heave the ice and thus break it apart.

(2) Large mudcaps (unconfined charges) are loaded on the top of the ice at frequent intervals, and fired.

As this work must, as a rule, be done on short notice, little time is afforded to obtain the correct explosive, so the recommendation is made for any low freezing dynamite available. Electric firing should be used for safety as well as for the benefits derived from all charges firing at exactly the same time.

Moving floes of ice must usually be broken by the second method. The explosive primed with a blasting cap and a short section of fuse can be dropped on the floe from the shore or from the down stream side of a bridge.

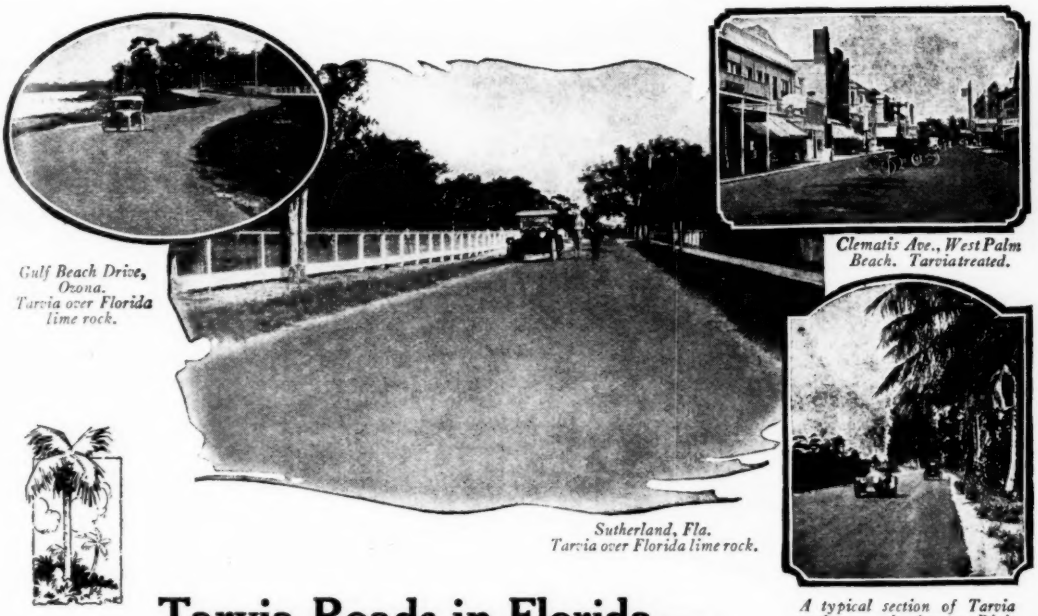
It is difficult to give any definite amounts of explosives to be used for blasting ice, but where the broken ice is 3 or 4 ft. thick, the charge of explosives should be not less than 10 lbs. Where the ice gorge runs up to 20 and 30 ft. in depth, it may require 1,000 or 1,500 lbs. of dynamite fired under it to obtain any results.

## GOOD YEAR FOR ENGINEERING EMPLOYMENT

All indications point to a banner year for engineering employment according to the Employment Department of the American Association of Engineers. Resumption of activities after the usual year-end pause has started with noticeable effects throughout the country. There is a great demand for engineers, particularly designing engineers, and salaries for these technical men have taken a broad increase during the past two months. An average increase on starting salaries amounting to over 10 per cent, has become effective in many organizations.

The structural steel line has been the most active during the past few months. The number of construction projects and volume has been large and more projects of this nature, particularly industrial buildings and highway construction, will be started this year. Indications are that all records will be broken. We will see a billion dollar improvement year for railroads.

In a survey made of the country, practically all sections show very little unemployment among professional engineers, a scarcity of men for engineering work, and office men are at a premium. The city of Los Angeles is required to hold up some important municipal projects because of its inability to engage competent checkers on the necessary plans. Conditions on the Pacific coast for engineers are excellent with the exception of the northwest where the winter season has tied up construction work. The southwest section of the country is fair and the mountain states are about balancing the supply and demand. The central states show the greatest activity in engineering work with practically no unemployment and an average of two positions for every competent designing engineer. The southern and south Atlantic states show activities fair with some construction work starting and highway work taking on activity. The eastern section shows some unemployment among engineers at the present time.



*Gulf Beach Drive, Ozona. Tarvia over Florida lime rock.*

*Clematis Ave., West Palm Beach. Tarviatreated.*

*Sutherland, Fla. Tarvia over Florida lime rock.*

*A typical section of Tarvia surface on the famous Dixie Highway, Palm Beach County.*

# Tarvia Roads in Florida—

By no means the least of the attractions that make Florida the "Winter Paradise of America" are the smooth dustless highways that connect the many coast and inland resorts. Many of them are Tarvia roads.

In building these highways the road officials are confronted by unusual conditions. The roads must stand up, with small maintenance cost, not only against heavy traffic but also against the summer rainfall and tropical climatic conditions.

The constantly increasing use of Tarvia in all sections of the State proves how satisfactorily Tarvia roads are meeting these requirements. Today, in Volusia, Brevard, Palm Beach, Duval, Pinellas and other counties, Tarvia roads are adding alike to the pleasure of winter tourists and to the comfort and prosperity of the year-round residents.

Because of their moderate first cost and easy and inexpensive maintenance Tarvia roads always permit a more extensive good roads program than is possible with any other type of modern highway construction.

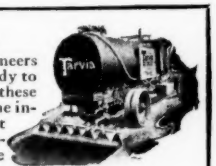
Our highway engineers are at the service of any community desiring better and more economical roads.

*Illustrated booklets describing the various grades and uses of Tarvia will be sent free on request.*

**Tarvia**
*For Road Construction Repair and Maintenance*

***Special Service Department***

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write our nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

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# Contracts Awarded

## ROADS AND STREETS.

**Ala., Birmingham**—Southern Roads Co., Birmingham, awarded contr. to build Pratt-Ensley Rd. at $81,306.

**Ala., Montgomery**—D. R. Cook & Co., Selma, awarded contr. for grading, surfacing and constructing creo. timb. brdgs. on 18.67 mi. hwy. from Montgomery Co. line to Union Sprgs. F. A. projects 1 and 68, Bullock Co. to D. R. Cook & Co., Selma, at $326,228; grading and gravel surfacing 13.-897 mi. Opelika-Waverly Rd. to R. D. Chambers & Co. West Point, Ga. at $172,049.

**Cal., Fresno**—W. F. Hanrahan, Griffith-McKenzie Bldg., awarded contract for impvt. of Divisadero, Tuolumne Sts., etc., at $70,849.

**Cal., Modesto**—N. M. Ball, Porterville, awarded contract for paving approx. 7.15 miles hwy. bet. Westley and Stanislaus-San Joaquin Co. line, at $138,912; A Teichert & Son, Sacramento, awarded contract for paving 3.13 miles hwy. bet. Oakdale and Escalon with asph. conc. and bitum. base, at $61,732.

**Cal., Sacramento**—State Hwy. Dept. let contract for surfacing with asph. conc. 5 miles hwy. bet. Roseville and Lincoln, Placer Co., to J. A. Costello, Jr., 512 Mission St., San Francisco, at $33,-530; gravel surfacing 11.9 miles bet. Willows and Glenn, Glenn Co., to V. R. Dennis Constr. Co., McMinnville, Ore., at $124,150; grading 8.9 miles bet. Parkfield Jct. and Coalinga, Fresno Co. to C. Miles, 2509 L St., Sacramento, at $120,803; paving with asph. macadam 8.2 mi. hwy. bet. Morrison's Crossg. and 1 mi. so. of Marysville to Blumenkranz & Vernon, Farmers & Merchants Bank Bldg., Stockton, $141,275; grading and paving with asph. macadam 8.2 mi. bet. Hollister and Pacheco Pass Rd. San Benito & Santa Clara Cos., to Granite Constr. Co. Watsonville, at $131,732; 14.2 mi. bet. westerly boundary and Califa, Madera Co. to R. T. Shea, 169 W. 7th St. Riverside, $193,648; grading and conc. paving 1.8 miles bet. Hercules and Rodeo, Contra Costa Co., to L. Tagnon, 1735 Napa St., Vallejo, at $33,519; grading 7.4 mi. bet. point 3.4 mi. southeasterly from Hueneme Rd. and Rindge Ranch, Ventura Co. to Hauser Constr. Co., 1109 Hobart Bldg., San Francisco, at $598,085.

**Cal., Sacramento**—V. R. Dennis Constr. Co. McMinnville, Ore., awarded contract for paving with asph. conc., 8.51 miles state hwy., Siskiyou Co., at $158,645; Geo. H. Oswald, 336 E. 58th St., Los-Angeles, contract for grading and paving with asph. conc., 9.36 miles state hwy., Imperial Co., at $143,055.

**Cal., Sacramento**—J. Wilmshurst & Thos. Manetos, San Francisco, awarded contract for grading abt. 3.3 miles State Hwy. Nevada Co. at $124,599.

**Que., Gentilly**—A. Heon & Co., 45 St. Antoine St., Three Rivers, Que., awarded contract for 8 miles macadam pavement. Steam rollers, stone crushers and dump carts required. Road will cost about $176,000. A Fraser, Engr.

**Fla., Jacksonville**—City Comn. has let following contracts: Jas. Y. Wilson, Jacksonville, at $6,631 to lay vit. brk. on conc. found. on Clay and Jefferson Sts.; at $159,203 for 6-in. conc. with bitum. mat on Ashley, 5th, Beaver, 4th, Hubbard, James. Market, 9th, Oak. Palmetto, 7th, 10th, 26th, Walnut Sts., at $8,349 to relay existing brk. with bitum. filler on Myrtle & Main Sts.; at $170,567 for 2-in. asph. conc. on 6-in. base on Cedar, College, Eagle, Gilmore, Herschel, King, Post, Park, St.-Johns; to Adams & Evans & Co., Jacksonville, at $42,093 to resurface existing brk. with Natural Lake sheet asph. on Ashley, Duval, Forsyth, Julia and Laura Sts.

**Fla., W. Palm Beach**—Greynolds & Moore, also Keystone Constr. Co., all W. Palm Beach, awarded contracts for paving 3 sects. in Paving Dist. No. 3, at $113,226.

**Ind., LaPorte**—Contract for gravel surfacing 28,-000 ft. Bear Rd., 16 ft. to G. H. Gross Constr. Co., Laporte, at $43,900; 9,000 ft. Bell Rd., 16 ft. to Taylor & Alkire, Laporte, at $25,449; grading and graveling 14,300 ft. Sellers Rd., 16 ft. to F. C. Teach, Rensselaer, $25,800.

**Ind., Terre Haute**—Carpenter Constr. Co. Terre Haute, awarded contract for graveling 8.5 mi. John N. White Rd., 30 ft. at $84,002; 13,400 ft. J. A. Crabb Rd. 16 ft., $25,978; 11,220 ft. Fromme Rd., 30 ft., conc. $80,762; J. M. Robertson, Terre Haute, 2.25 miles George Woodsmall Rd., 16 ft. $25,834.

**Ind., Warsaw**—Indiana Constr. Co., Warsaw, awarded contr. for paving 12,324 ft. East Market St., 45 ft., 61,633 ft. asph. on concrete, at $93,051.

**Iowa, Elkader**—McKusick Constr. Co., 3916 Richfield Rd., Minneapolis, Minn., awarded contract for paving curbing and grading here at approx. $85,-000.

**Iowa, Marion**—Moore & Young Constr. Co., Waterloo, awarded contract by Linn Co. for conc. paving and incidental work on 5.589 mi. primary road from Cedar Rapids east, FAP 96; 61,146 sq. yds. conc., 16,134 c.y. excav., at $187,168.

**Kans., Independence**—Cornelison & Kelly, Wichita, awarded contr. by Montgomery Co. Comrs., for paving 4.51 miles Independence-Caney Rd. 121, Sec. A., 18 ft., bitum. macadam, at $92,306; 4.855 miles Independence-Caney Rd. FAP 121, Sec. D, 18 ft. bitum. macadam, to A. G. Sherwood, Independence, at $115,998.

**Ky., Earlington**—Southern Roads Co. awarded contract to grade and drain several streets at $125,000; 30,000 sq. yds. rolled stone base, Warrenite Bitulithic surf.

**Ky., Frankfort**—8.8 miles Crittenden-Louisville-Paducah Rd. contract let to Brantley and Costello Bros., Knoxville, Tenn., at $86,493; 5 mi. Powell-Stanton-Winchester Rd., to Ellis & Smeathers, Owensboro, Ky., at $59,869; 9.6 miles Henifee-Frenchburg-W. Liberty Rd. to same contractor at $82,259.

**La., Baton Rouge**—La. Hwy. Comn., let contracts for 2 sects. of rds. on Dixie-Overland Hwy as follows: 18.45 mi. bet. Delta Point, opposite Vicksburg and Tallulah, Madison Parish, to Hogsett & Co., East Point, at $213,249; 14.46 miles bet. Ruston and Arcadia, Lincoln Parish, to C. W. George & Co., Arcadia, at $180,847.

**Mich., Lansing**—Following Mich. Fed. Aid Rd. contracts let: Wayne County Rd. Comn., Detroit, Mich. award. contract for Rd. F. A. 62, Wayne Co. Greenfield, Redford, Livonia and Plymouth Twps., Cl. F (rein. conc.) 20 ft. wide, 14.865 miles, to Wayne Co. Rd. Comn., Detroit, at $559,804; Rd. F. A. 80 F, Mackinac Co. Moran and Brevoort Twps., Cl. B-gravel, 18 ft. wide, 12.871 mi. to S. J. Groves & Sons Co. Duluth, Minn., at $155,347.

**Miss., McComb**—Lawrence, Nixon & Phillips, Jackson, awarded contract for curbing, guttering, grading and bldg. walks, $100,000.

**Mo., Albany**—W. R. Larson Constr. Co., Sioux Falls, S. D. awarded contract for road work in Gentry and Harrison Cos., at $490,000.

**Mo., Jefferson City**—State Hwy. Dept. let contracts to grade, construct draining structs. etc. on 3 roads as follows: Maries Co., 4.061 mi. gravel surf. rd.—Vienna northeastward, SAP Route 7, Sec. 5, to Birmingham & Terry, Vienna, Mo., at $17,819; Laclede and Pulaski Cos., .862 mi. rd. from Lebanon to Pulaski Co. line, R. 14, Sects. 38 and 45, to Reiley and Bailey, St. Louis, at $172,000.

**Mo., Jefferson City**—State Hwy. Dept. let contracts for 8 roads as follows: Barry Co. 4.84 mi. gravel rd. to Allhands & Davis, Joplin, Mo. at $38,418; Maries Co. 4.6 mi. gravel surf. rd. from Vienna to Osage Co. line, to Birmingham and Terry, Vienna, Mo. at $17,819; St. Geneveive Co., 4.84 mi. gravel surf. road thru Co. to Allhands & Davis, Joplin, at $27,855; New Madrid Co. 3.5 mi. gravel surf. rd. east of Risco, to Novaculate Construction Co., Marion, Ill. at $45,830; Carter Co. 4.48 mi. from Elsinore to Poplar Bluff, to W. A. Leach, Poplar Bluff, at $11,772; Johnson Co. 4.2 mi. rd. to J. W. Wilson, Warrensburg, Mo. at $22,-289; Harrison Co. 3.53 mi. conc. surf. rd. west of Bethany, to Rand Constr. Co., Kans. City, at $136,-769; Howell Co. 4.6 mi. gravel rd. bet. Willow Springs and Mtn. View, to W. F. Plummer Constr. Co. Springfield, at $37,700. Dunklin Co. grade, gravel and brdg. 11 miles road northwest from Holcomb, includg. brdg. over St. Francis River, to U. E. Gillioz, Monett, Mo., at $330,000.

**Nev., Carson City**—Contracts awarded as follows by State Hwy. Dept.: Wasatch Grading Co., Provo, Utah, at $61,616; for grading and graveling abt. 8.2 mi. Clark Co. to Western Engineering & Con-

struction Co., bid $64,105; Kroft & Bundy, Ogden, awarded contract for grading and graveling 9.56 mi. hwy. in Lincoln Co., at $52,576; Dodge Bros. & Dudley, Fallon, awarded contr. for grading 4.99 mi., Churchill Co., at $21.992.

**N. Y., Long Island City**—Necaro Co. 97 Court St., Brooklyn, awarded contract for repaving Grand St., with granite blk. at $117,978.

**N. Y., New York**—D. J. McCarthy, 88 Audubon Ave., awarded contr. for repaving Broadway at Canal St., and Bway. at Chambers St., at $6,198 and $5,542 respectively; West Street to W. J. Fitzgerald, 547 W. 45th St., $244,169; Dyckman St., 5th & Lenox Aves., to C. D. Beckwith, 2875 Bway., $22,424, $96,600 and $58,444, respectively.

**Ohio, Canton**—G. Hadley, 302 Goldberg Bldg., Market Ave., S. Canton, awarded contract for paving, etc. 4 miles Alliance-Minerva Rd., 16 ft. vit. brk. at $153,330.

**Okla., Okla. City**—M. R. Ammerman, 246 N. Market St. Wichita, Kans., awarded contract for hard surfacing on low type paving 31.0729 miles FAP 84. Le Flore Co., at $424,707.

**Ore., Eugene**—Warren Constr. Co. awarded contract to construct Goshen-Lowell sect. of Willamette Hwy., at $82,571; A. C. Mathews, Eugene, contr. to build Cheshire-Goldson Rd., at $40,920; E. D. Olds, contract to construct Lost Creek brdg., net. Trent and Dexter at $9033.

**Pa., Harrisburg**—State Hwy. Dept. Harrisburg let contr. for 21,986 lt. Route 243, Sec. 2, Industry Twp. Beaver Co., 26,776 c.y. excav., 45,121 sq. yds. rein. conc., to Chester General Contg. Co., P. O. Box 7 781, E. Liverpool, O., at $203,961; 23,024 ft. Applications 1092 and 1096, Farmington and Pine Grove Twps. Warren Co., 22,103 c.y. excav., 41,063 sq. yds. rein. conc. to F. C. Chiode, assigned to Chiode & Foley, Sheffield, at $164,490.

**S. C., Greenville**—J. T. Blassingame, Greenville, awarded contr. to topsoil 15 miles Jones Gap Road, at $178,000.

**Texas, Bonham**—Julian C. Field & Co., Denison, awarded contr. for const. of 5.66 miles 18-ft. conc. roadway. Type B, at $174,629.

**Texas, Crockett**—Smith Bros., Crockett, awarded contract for 6.9 miles S. H. No. 21, extending from present F. A. Project, at $120,000.

**Tex., Hondo**—Kuykendall & Shelton, Temple, awarded contr. for grading and gravel surfacing 23.53 miles hwy. 18 ft., Medina Co., at $149,388.

**Va., Richmond**—State Hwy. Dept., let contr. for 9.95 miles Proj. 169-B, Botetourt Co., bitum. macadam to W. W. Bosley, Roanoke, at $215,643; 6.28 mi. Proj. 186-A, Pittsylvania Co., plain conc. to Overstreet & Nance, Bedford, at $184,528; 9.91 mi. Proj. 205, Spottsylvania Co. plain conc. to Spottsylvania Constr. Co., Highland Spring, at $305,572.

**Wash., Spokane**—Independent Asphalt Paving Co., Seaboard Bldg., Seattle, awarded contract by Bd. Spokane Co. Commrs., for 8.50 miles 7-in. conc. road at $219,094. Work will be on Trent Rd. nr. Spokane. Work will involve 7-in. conc. with longitudinal expansion joints.

**Wyo., Cheyenne**—Wickham Bros. & Schweiger, Lovell, awarded contr. by State Hwy. Dept., for grading and draining 118-A, Laramie Co., 7.789 miles FAP., at $138.869.

## SEWERAGE AND SEWAGE TREATMENT.

**Cal., Santa Ana**—Waterworks Supply Co., Wright & Callender Bldg., Los Angeles, awarded contract for sewage screening plant, in connection with new treat. plant and joint outfall sewer project, at $39.987.

**Cal., Santa Ana**—B. R. Ford, 407 W. 17th St. awarded contract for constr. of new main line outfall sewer. conc. pipe, at $100,078.

**Ont., Hamilton**—Hamilton Contg. Co. Home Bank Bldg., awarded contract for 2,480 ft. sewer in King and McKittrick Sts., at $61,770.

**Cal., Watts**—J. G. Beckjord, 718 San Fernando Bldg., Los Angeles, awarded contract for constr. of city sewer system, at $445,000.

**Ont., Hamilton**—Cope & Sons, 29 Albert St. awarded general contract for sewers at $29,430. E. R. Gray, Engr.

**Ont., Sandwich**—Merlo, Merlo & Ray, Sandwich Street, Ford, awarded contract for sewers in Askin Blvd., Randolph St. and Rankin Ave. up to 18 in. at $143,871.

**Ont., Toronto**—Murphy Contracting Co. Toronto, awarded contr. for sewers in Farnum Ave., at $5.760; Badmoral Ave., $7,940, Grenadier Rd., $3,552; John McKnight Constr. Co., 88 St. Davids St., sewer exten. in Dundas St., $2,285; National Contg. Co., 9 Garnock Ave., sewer in Riverdale Ave., $2,158; Duplex Ave., $5,989; to F. F. Fry Ltd., 43 Scott St. sewer in Blvd. Drive at $20,312; Work involves 10,000 ft. 8-12 in. glazed tile sewers.

**Cal., Turlock**—W. J. Tobin, 527 Santa Ray Ave., Oakland, awarded contract for constr. of outfall sewer, 12,750 ft. 24-in. glazed cement pipe at $25,-832.

**Fla., Jacksonville**—Contract for constr. of storm water and san. sewers in Secs. A and E, to Bryan & Co. Jacksonville, at $29.809 and $58,122 respectively; Secs. C, D and F to Adams-Evans & Co., Atlantic Bank Bldg., at $26,890, $50,023 and $28,-373, respectively; Sec. B, Adams-Evans & Co., Atlantic Bank Bldg. and Bryan & Co. Jacksonville.

**Ind., Michigan City**—Byrne Bros. Constr. Co., 358 E. 115th St. Chicago, awarded contract for constr. of trunk sewer, at $507,000.

**Kans., Oakley**—Reed & Wheelock, Clay Center, awarded contr. for complete new sewerage system and disp. plant, at $47,284.

**Mich., Springwells**—W. Blanck & Co., 827 Ford Bldg., 3,315 ft. Sec. 23 in Marconi, Springwells and Pompeii Sts., at $43,200.

**Minn., Hibbing**—Nick Ohman & Co., awarded contract for san., sewers at $11,787, Sargeant Addn. Bellanger-Lindberg Co. at $24,843, Ansley Addn., Home Acres Blvd.

**Minn., So. St. Paul**—Thornton Bros. Co., 306 Central Bank Bldg., St. Paul, awarded contract for sewer extensions at $115,000.

**Mont., Winnett**—Two Miracle Concrete Co. Ford Bldg. Great Falls awarded contract for 3-4 mile trunk and lateral sewers at $37,000.

**Neb., Clay Center**—Asplund Constr. Co., Tecumseh, awarded contract for laying sewers at $38,-585; disposal plant to W. B. Carter, Sioux City, Ia., at $20,000.

**Ohio, Akron**—W. P. Gibbons Constr. Co., 343 Arcade, Cleveland, awarded contract for Little Cuyahoga River Interceptor Contr. 3, 5, 500 ft. 8-in. vit. clay pipe at $0.60 per ft., 4,830 ft. 57-in. brick sewer open cut $28, 675 ft. 57-in. brick sewer in tunnel at $56.20—total $200,000.

**Ohio, Cleveland**—Gallagher Burke Constr. Co., 1228 Bonnieview Ave., Lakewood, awarded contract for 4,193 ft., 66 and 72 in. segmental blk. sewer in Sewer Dist. 1, Impvt. 26, Sec. A, at $160,000.

**Okla., Bristow**—Fielder & Eads, Bristow, awarded contract for 8,000 ft. 8-12 in. vit. san. sewers, also sprinkling filter, at $32,628 and $19,079 respectively; 7,000 ft. 48-in. segmental blk. st. sewers, to Standard Paving Co., 1742 E. 4th St., Tulsa, at $59,397.

**Okla., Sand Springs**—Comstock & Smedley, Tulsa, Okla., awarded contract for monolithic conc. storm and san. sewers for 36-in. to 72-in. remainder vit. at $75,938.

**Pa., Philadelphia**—R. Lombardi, Lincoln Bldg., awarded contract for sewer in York Rd., $28.004; also sewer in Salmon, Stockley, Walker and Watts Sts., 67th and Torresdale Aves., at $26,672; J. J. McHugh, 1716 Race St., sewer in Haines, Howard and McCollum Sts., $27,025; W. H. Garson, 5033 Brown St., sewer in McKean, Oxford and Sansom Sts., $18,835, Erie Ave. Carson, 54th and 55th Sts., $27,227; E. T. Bennis, 641 E. Chelton Ave. sewer in Washington Lane, Ellett and Ognotz Sts., $33,365; E. Leva, 3851 N. 10th St., sewer in 65th Ave. American, Atlantic, Kingston, Venango and Ognotz Sts., $34,039; to E. Pascuzzi, Lincoln Bldg., sewer in Abbotts Av., Louden and Arnold Sts., at $29,877; A. Joffola, 1203 Tree St., intercepting sewer in 40th Ward lowlands, $43,586.

**S. D., White Lake**—Following contracts let: Sewage disp. plant to K. A. Kobes, Mitchell, at $19,880, Imhoff tank and filter beds; san. sewers to O. N. Gjellefald Constr. Co. Forest City, Ia.; also deep well pump and water works service pump, at $25,159.

**Tex., Houston**—E. K. High, 2408 Fletcher St. awarded contr. for san. sewers in Webster and Shepherd Sts., at $27,432; C. K. Horton, Box 1394, san. sewers Electric Park at $9,716. Lubbock St., $6,673, Quitman & Davis Sts., etc., $8,983, W. Webster St. $15,010.

**Wis., No. Milwaukee**—Balliet Constr. Co., Adams

Ave., Milwaukee, awarded contract by Met. Sewerage Comn. of Milwaukee Co., 508 Market St. Milwaukee, for main sewer in 32nd St. and Hampton Ave. to 48th St. and Roosevelt Dr., at $297,725.

### WATER SUPPLY AND PURIFICATION

**Que., Montreal**—E. G. N. Cape & Co., Cathcart Street, awarded contract for constr. of 46x58x103 ft. rein. conc. brk. and steel distribution control bldg. for new pumping station Atwater Ave., at $167,000.

**Ill., Mt. Prospect**—C. Porter Co., 111 W. Washington St., Chicago, awarded contract for water works constr. at $57,000.

**Ia., Chariton**—A. Phelps & Son, Knoxville, awarded contr. for settling basin bldg., at $11,380; Pittsburgh Filter Co., Des Moines, contr. for filtr. plant including 2 filters, at $6,575.

**Kans., Abilene**—Burt & Tripp, Herington, awarded contr. for pipe line, at $15,964; Chicago Bridge and Iron Co., 37 W. Van Buren St. Chicago, 250,000 gal. tank on 100-ft tower, at $14,090; Fairbanks-Morse Co., 1218 Liberty St. Kans. City, Mo., one 75-h.p. engine, $5,190 and two 250-h.p. motors, at $1,923.

**La., Houma**—Merkle Machinery & Contracting Co., Kansas City, Mo. awarded contract for constr. of complete power, light and water filtr. plant. Approx. cost $250,000.

**Minn., Minneapolis**—City will install pumping unit and filter plant by Day Labor; 40,000,000 gals. daily capy. Est. cost $2,673,360. Project will take 3 years to complete. N. W. Elsberg, City Engr.

**Miss., Bay St. Louis**—Contract for 3 motor driven fire pumps award. to Southern Jobbers Supply Co., 515 S. Peters St., New Orleans, La., at $3,880; steel tower and tank to Pittsburg-Des Moines Steel Co., Praetorian Bldg., Dallas, at $5,540; pipe and specials, steel pipe fittings, to Natl. Cast Iron Pipe Co., Trrant City, Birmingham, Ala., at $26,462; conc. reservoir, hauling pumps, installing same found. for pump house, bldg. pumphouse and hauling material for same, to Chambers and Bowers, Hammond, Ind.

**N. Y., Mayfield**—H. W. Golden & Son, Inc., Troy, awarded contr. for water system at $32 269; steel water tank to Pittsburgh-Des Moines Steel Co., 50 Church St., New York City, at $11,000.

**Okla., Bristow**—Fielder & Eads, Okla. City, awarded contract for constr. of filtration plant., extensions to sanitary sewers and laying of large water mains, erecting 100,000 gal. elevated water tower; also contract to Standard Paving Co., Tulsa, awardedcontract for construction of 2 storm sewers at $59,397.

**Okla., Okla. City**—Rhinehart & Donovan, Tradesmans Natl. Bank Bldg., awarded contr. for three 3450 gal. per minute centrif. pumping units driven by Marine type high speed engines, at $27.520.

**Okla., Okla. City**—Sherman Iron Works, E. Main St., awarded contr. for extending water and sewerage systems, at $29,700.

**Pa., Phila.**—U. S. Cast Iron Pipe & Found. Co., Morris Bldg., awarded contract for furnishing 6, 8 and 12 in. cast iron pipe, at $26,280; 6, 8 and 12 in. stop valves, also fire hydrants, to A. P. Smith Mfg. Co., Norman St., E. Orange, N. J., at $8,274 and $17,025, respectively.

**Pa., Phila.**—Roberts Filter Co., Rawn & Tacowanda Sts., awarded contract for water piping in Northeast sewage treatment plant, at $101,900.

**S. Dak., Rapid City**—Following contracts let: reservoir to Duhamel Co., Rapid City, at $89,820; 2,000,000 gal. r.c.; 2—cast iron pipe to Conc. Engr. Co., at $37,752 f.o.b. Rapid City; 3—Jute, Lead, Fire hydrants, to Hendrei-Bolthoff, Denver, Colo., jute & lead, $6,018; fire hydrants, $6,353; 4—Laying 12 ft. pipe Dobson Co., 809 1st Natl. Bank Bldg., Lincoln, $26,742.

**Texas, Quanah**—Janes Construction Co., Dallas, awarded contr. for constr. and piping of complete water wks. system, at $60,642.

**Wash., Seattle**—R. G. Stevenson, awarded contract for water mains and hydrants in 2nd Ave. northwest, et al, at $15,206; F. Lupis, contract for water mains and sewers in 24th Ave., south et al—$21,591 for clay and $21,470 for concrete; R. G. Stevenson, contract for water mains in W. 53rd St., at $2,760; also contract for water mains in 12th Ave. northwest at $8,903.

# Prospective Work

### ROADS AND STREETS.

**Ark., Ft. Smith**—Sebastian Co. plans bldg. 18 mi. hard surf. road bet. Greenwood and Ft. Smith, $94,000. Half from Fed. and State governments.

**Que., Montreal**—Metropolitan Comn., having plans prepared for opening and paving 35-mile boulevard at cost of $2,000,000. S. Fortin, Secy.

**B. C., Victoria**—Provincial Government, Victoria, has appropriated $1,326,500 for new roads in various towns and cities. W. H. Sutherland, Minister of Public Works.

**Fla., Bradentown**—Manatee County Commrs., plan completing 48-mile road; voted $150,000 bonds. McElroy Engrg. Co. Engrs., Tampa, Fla.

**Fla., Sebring**—$600,000 bonds voted by Highland County for constr. of 110 miles of road.

**Ill., DeKalb**—City making plans to pave 8,000 yds. Normal Rd., at cost of $30,000; 20,000 yds. West Lincoln Hwy., $80,000. Consoer. Engrg. Co., 140 S. Dearborn St., Chicago, Cons. Engrs.

**Ia., Bettendorf**—Plans under way for laying brk. paving on Washington Ave. 15 blocks, thru business dist. 50 ft. wide. N. H. Tunnicliffe, City Engr. H. F. Abramson, City Clerk. Est. cost $80,000.

**Ky., Frankfort**—State Hwy. Comn. will grade 26 miles dirt rd. thru Morgan Co. May purchase conc. mixer, wagon loaders, scrapers and culverts, paving materials, including road oil and road binders. Lynn B. Wells, Atty., W. Liberty.

**Ky., Owenton**—Owen County—N. B. Smith, Co. Judge, plans bldg. Owenton-Frankfort Rd. $500,000 bonds voted.

**La., Bastrop**—Morehouse Parish Police Jury (W. Smith, Pres.) will build 150 miles of highway in Dists. 1 and 2. $1,150,000 bonds voted.

**La., Winnsboro**—Franklin Parish Police Jury plans expendt. of $400,000 for highway bldg., including 25 miles of road from Winnsboro to Delhi.

**Md., Baltimore**—Paving Commission—R. Keith Compton, Chrmn., 214 E. Lexington St., has approved paving portions of 13 streets on 50-50 basis.

**Mich., Sault Ste Marie**—Tentative street impvt. program for City for 1923 provides for paving portions of 6 streets. Bonds in sum of $75,000 will be sold for the street work.

**Minn., Duluth**—Will soon ask bids for paving various streets and 20 alleys. $200,000 bonds adopted at election Jan. 23. Est. cost $1,000,000. J. A. Farrell, Commr.

**Miss., Biloxi**—City Commission plans improving streets and roadways, parks and playgrounds, bldgs., etc. Considering voting on $550,000 bonds in about 30 days.

**Mo., Jefferson City**—City considering surface treating and repairing 31 streets. City Engr. Ross.

**Mont., Missoula**—Following projects to be constructed in 1923: 12 miles rd. bet. Arlee and Ravalli, $135,000; 6 mi. gravel rd. bet. Ravalli and St. Ignatius, $45,000; Sanders Co. 7 mi. gravel rd. from Dixon W., $50,000; 12 mi. gravel rd. from Dixon W., $50,000; 12 mi. gravel rd. bet. McDonald & Knowles, $83,000; A. M. Johnson, Co. Clk. Thompson Falls. Flathead County: 13 1-2 mi. gravel rd. from Pablo to Rollins, $287,500; E. E. Stewart, Co. Clk. Kalispell, $20,000. Probably construct one-half mile rd. at Turrah, $50,000 and 9 miles rd. bet. Bearmouth and Drummond, $85,000.

**N. C., Asheville**—City plans improving streets, sidewalks and water system at cost of $550,000. Gallatin Roberts, Mayor. Buncome County Commrs. plan expending $200,000 for road impvts. E. M. Lydia, Chrmn. Comn.

**Okla., Purcell**—Resolutions passed by Legislative Council of City, authorizing paving of 40 additional blocks. Benham Engrg. Co., Kansas City, Engrs.

**Okla., Tulsa**—Tulsa County having plans prepared for road work. May vote on $2,000,000 bonds. D. W. Patton, Court House Bldg., Engr.

**Ore., Salem**—Income of State Hwy. Dept. for 1923-24, as estimated by State officials, will aggregate $21,250,000. With exception of $7,000,000 all this money is obligated in connected with fixed expenses which include maint. bond interest, operating expenses and other items. Of the $7,000,000 not already obligated $750,000 will go to Fed. Govt. for

# BUYERS' GUIDE

**Aerial Tramways.**
American Steel & Wire Co.

**Air Lift Pumps.**
Harris Air Pump Co.

**Armor Plates.**
Truscon Steel Co.

**Asphalt.**
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

**Asphalt Filler.**
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

**Asphalt Floors.**
The Barrett Co.
The Texas Co.
Warren Bros. Co.

**Asphalt Machinery.**
Cummer & Son Co., The F. D.

**Asphalt Plants.**
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

**Asphalt Railroad Plants.**
Cummer & Son Co., The F. D.
Warren Bros. Co.

**Asphalt Tools.**
Littleford Brothers.
Warren Bros. Co.

**Asphalt Tool Wagons.**
Littleford Brothers.

**Auto Fire Apparatus.**
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Back Fillers.**
Austin Machinery Corporation.
Pawling & Harnischfeger.

**Bar Cutters and Benders.**
Koehring Machine Co.

**Bars, Reinforcing.**
Truscon Steel Co.

**Binders, Road.**
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

**Bitulithic Pavements.**
Warren Bros Co.

**Blasting Accessories.**
E. I. du Pont de Nemours & Co., Inc.

**Blasting Powder.**
E. I. du Pont de Nemours & Co., Inc.

**Bodies.**
Lee Trailer and Body Co.
Littleford Brothers.

**Braces, Extension.**
Kalamazoo Fdy. & Machine Co.

**Brick Rattlers.**
Olsen & Co., Tinius.

**Brick-Testing Machinery.**
Tinius Olsen Testing Mach. Co.

**Bridges.**
Lewis-Hall Iron Works.

**Buckets, Dredging, Excavating and Sewer.**
Pawling & Harnischfeger.

**Buckets, Dumping.**
Littleford Brothers.
Pawling & Harnischfeger.

**Cableway Accessories.**
Sauerman Bros.

**Cableway Excavators.**
Sauerman Bros.

**Calculators.**
Kolesch & Co.

**Car Unloaders.**
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

**Castings.**
U. S. Cast Iron Pipe & Fdy. Co.

**Cast Iron Pipe.**
U. S. Cast Iron Pipe & Fdy. Co.

**Catchbasins.**
Dee Co., Wm. E.
Madison Foundry Co.

**Cement Testing.**
Kirschbraun, Lester.

**Cement Testing Machinery.**
Tinius Olsen Testing Mach. Co.

**Central Heating Plants.**
American District Steam Co.

**Chimneys, Concrete.**
Truscon Steel Co.

**Chimneys, Steel.**
Lewis-Hall Iron Works.
Littleford Brothers.

**Chloride of Lime.**
Pennsylvania Salt Mfg. Co.

**Chutes, Concrete.**
Heltzel Steel Form & Iron Co.
Littleford Brothers.

**Concrete Mixers.**
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

**Concrete, Reinforcement.**
American Steel & Wire Co.
Truscon Steel Co.

**Conduits.**
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

**Conduit Rods.**
Stewart, W. H.

**Conduits, Wood, Creosoted.**
Republic Creosoting Co.

**Consulting Engineers.**
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

**Contractors.**
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

**Contractors' Tools and Machinery.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

**Contractors' Wagons.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

**Conveying Machinery.**
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

**Cranes and Hoists.**
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

**Creosote.**
The Barrett Co.
Republic Creosoting Co.

**Creosoted Wood Block.**
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

**Crushers, Rock and Ore.**
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

**Culvert Pipe, Vitrified.**
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

**Culverts.**
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

**Curb and Gutter Forms.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Curb Bar.**
Truscon Steel Co.

**Direct Oxidation Process.**
Direct Oxidation Process Corp.

**Disinfectants.**
Integrity Chemical Co.

**Drag-Line Excavators.**
Austin Machinery Corporation.

**Drag Scrapers.**
Austin-Western Road Machinery Co.

**Drain Tile.**
Dee Clay Mfg Co., W. E.

**Drawing Materials.**
Kolesch & Co.

**Dryers.**
Cummer & Son., The F. D.

**Dump Cars.**
Austin-Western Road Machinery Co.

**Dump Wagons.**
Austin-Western Road Machinery Co.

forest rds. Approximately $500,000 will be expended for completing post rds. and $3,500,000 in post rd. projects not yet agreed upon by st. state and government. Approx. $2,500,000 will be on hand for road constr. over which Bureau of Pub. Rds. has no authority. On Jan. 1st there was in State Hwy. fund, exclusive of market rd. money, $2,256,179. Added to this will be authorized bond issues and earnings of St. Hwy. equipt. dept., aggregating not less than $8,574,000.

**Pa., Scranton**—City considering regrading and repairing unpaved streets at cost of $55,000; also relaying asph. pavement on several streets; $32,000. W. LaFontaine, Direct. Pub. Wks.

**S. Dak., Hayti**—Will call for bids for FAP 136, Hamlin Co., from Hay so. to county line, 8.5 mi. Est. cost $48,893. H. L. Stearns, Aud.

**S. D., Howard**—Miner Co. will ask bids in Sprg. for Proj. 133, west county line to Roswell, 7 miles. Est. cost $34,376, W. E. Leonard, Aud.

**S. D., Parker**—Bids will be asked in Spring for FAP 129, grading and graveling, Turner Co. 9.6 mi. O. M. Rasmussen, Aud. Est. cost $84,788.

**Tex., Angleton**—Brazoria Co. plans highway improvements in Anchor-Sandy Point Rd. Dist. $160,000 bond issue available. E. Gustafson, Co. Engr.

**Tex., Athens**—Henderson County plans bldg. rds. Contemplates voting on $1,700,000 bonds.

**Tenn., Elizabethton**—State Hwy. Dept. Nashville, plans to build road bet. Elizabethton and Hampton, Carter Co. $193,000.

**Tex., Eldorado**—Schleicher Co.—W. F. Ford, Co. Judge—plans 9.75 miles 16-ft. bitum. macadam road on S. H. No. 4. Est. cost $120,900. J. L. Miller, Co. Engr.

**Tex., Franklin**—Robertson Co., Hearne Road Dist. will improve and resurface roads. $200,000 bonds voted.

**Texas, Hemphill**—Sabine Co., plans 11.2 miles gravel surf. rd. on S. H. 21, $130,000. W. A. French, Co. Engr., San Augustine.

**Tex., Kaufman**—State Hwy. Dept. Austin, has approved plans for 6.67 miles 18-ft. gravel bitum. rd. on S. H. No. 15, Terrell Precinct, Kaufman Co. from Van Zandt Co. line west. Est. cost $90,080. W. D. Williamson, Co. Judge, Kaufman.

**Tex., Nacogdoches**—City will improve streets. $225,000 bonds voted. W. T. Baker, Mayor.

**Tex., Palo Pinto**—Palo Pinto Co., E. L. Pitts, Co. Judge, plans bldg. 2 bitum. macadam surfaced rds.; 6 mi. Bankhead Hwy. from Metcalf Gap to Palo Pinto, $191,500; 10 mi. no. branch Bankhead Hwy. bet. Metcalf Gap and Stephens Co. line, $280,000. G. W. Courter, Co. Engr.

**Tex., Rock Springs**—Edwards County, A. P. Allison, Co. Judge, considering 22.5 miles macadam surfaced rd. on Rock Springs-Kerrville Rd., FAP 335. Est. cost $200,720. W. E. Simpson, Co. Engrs., 414 National Bank Bldg., San Antonio.

**Tex., Ft. Worth**—Bureau Pub. Rds., has approved plans for 2 sections of roads as follows: 7.71 mi. crushed rock surf. rd. on S. H. No. 31, Corsicana-Waco Hwy., Navarro Co., FAP 329; $90,871; FAP $40,000; 29-mile graveled road from Hidalgo Co. line to Roma, Starr Co., $185,118, Fed. Aid, $75,000.

**Va., Princess Anne**—Princess Anne Co., Lynnhaven Rd. Dist. considering constr. of hard surfaced roads including road from Va. Beach to Cape Henry. Contemplates voting on $250,000 bonds.

**Wash., Seattle**—Street impvts. will cost City $5,000,000 for year 1923. Work consists largely of paving, grading and filling; also largest sewer job ever put over as a single impvt. Ten miles of sewers will be installed along 30th Ave., southwest and along slope of W. Seattle peninsula—California Ave. to Youngstown. Cost of this proj. not estimated. Paved outlet from Rainier Valley to industrial sect. of Duwamish Valley and tideflat area will be provided when grading and paving of Columbian Way to Empire Way and Alaska St. is completed. Paving W. 56th St. in Ballard will provide paved connect. with government locks. Hearing for bids on this job will be held soon. Paving of wholesale district., below Yesler way to Jackson street regarded as one of the most desirable improvements from business standpoint.

**W. Va., Charleston**—City will let contracts about Mch. 1st for 50,000 sq. yds. paving, 15 streets. Ernest Bruce, City Engr.

**W. Va., Spencer**—Roane Co., Harper Road Dist., plans grading roads bet. Walton Dist. line and Kanawha Co. line, via Harmony and Caldwell Gap; contemplates voting in June on $80,000 bonds.

**Wis., Alma**—Buffalo Co. has appropriated $168,941 for county and state aid road and bridge construction; also $3,000 for purch. of road machinery (type not decided on). J. Reinhardt, Nelson, Commr.

**Wis., Eagle River**—Vilas County has appropriated $42,706 for co. and state aid road and bridge constr. also $7,000 for purch. of road machinery, including trucks. Wm. F. Hunter, Commr.

**Wis., Hudson**—St. Croix Co. has appropriated $13,000 for purchase of road machinery, including caterpillar tractor, large grader, patrol graders, wheelers, slips and planes. J. Caffrey, Hammond, Commr.

**Wis., La Crosse**—La Crosse Co. has appropriated $334,233 for co. and state aid road and bridge constr.; also voted $240,000 bonds for road work and making up 1922 tax budget. La Crosse Co. voted $15,000 for purchase of rd. machinery. Jno. Hintgen, Commr. Type of mchy. undetermined as yet.

**Wis., Ladysmith**—Rusk County Bd. has voted $5,000 for purch. of road machinery, including patrol graders; also $58,960 for county and state aid road and bridge constr. Phil Koehler, Commr.

**Wis., Prairie Du Chien**—Crawford County appropriated $64,080 for Co. and State Aid Rd. and brdg. constr. J. N. Campbell, Bell Center.

**Wis., Rhinelander**—Oneida Co. appropriated $98,158 for co. and state aid road and bridge constr.; also $10,000 for purch. of road mchy., type undetermined. B. L. Horr, Commr.

**Wis., Waukesha**—Waukesha County has appropriated $617,890 for co. and state aid road and brdg. constr. Chet J. Hahn, Commr.; also $8000 for purch. of rd. machinery, including tractor and possibly large grader; also $2,500 for snow removal purposes.

**Wisconsin**—Ellsworth-Pierce County Bd. appropriated $51,132 for co. and state aid rd. and brdg. constr. in 1923; also $5,000 for purch. of rd. mchy. including patrol graders. C. F. Kendall, Commr. Monroe, Green County $642,982 for co. and state aid rd. and brdg. constr., also $30,000 for rd mchy. including outfit and tractor. C. J. Smith, Commr. Juneau, Dodge County appropriated $2,175,000 for co. and state aid rd. and brdg. constr.; also $10,000 for rd. mchy. Kind undetermined. E. T. Klug, Commr. Dodge Co. has also appropriated $5,000 for machine shop and equipment. Monroe, Green Co. Bd. appropriated $30,000 for maint. of state and co. rds. Phillips, Price Co. appropriated $18,000 for maint. of state and county roads. B. M. Griffin, Commr.

## SEWERAGE AND SEWAGE TREATMENT

**Cal., Fullerton**—Bond issues for outfall sewer carried at recent election. $75,000 issue to pay City's share of cost of joint outfall sewer to ocean; the $175,000 issue for sewer line connecting with Anaheim main line to joint outfall to be built by cities of Santa Ana, Anaheim, Fullerton and Orange.

**Cal., Orange**—It has been definitely decided to run City's main line sewer (portion of new intercity outfall sys.) from Orange to join main line of Anaheim sewer to treat. plant at pt. where P. E. Ry. trks. cross Garden Grove Rd. east of Garden Grove. Line est. to cost $55,000.

**Cal., Pomona**—City Engr. E. C. Froehde and Mayor Ovington, recommend bond issue of $100,000 for new municipal sewer system.

**Cal., Richmond**—Prelim. plans prepared for storm sewers in various sections of City. $350,000-$400,000. H. D. Chapman, City Engr.

**Cal., Santa Barbara**—City Engr. Geo. D. Morrison reports that he is preparing plans and specfs. for 34 sewer construction jobs, many of which will be under way this Spring. Ten sewer contracts are under way and others will be started immediately.

**Ont., Sandwich**—Town Council having plans prepared for $150,000 sewage disposal plant. Archts. McColl & Patterson, Gas Bldg. By-law passed authorizing construction.

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**Dust Laying Compound.**
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

**Dynamite.**
E. I. du Pont de Nemours & Co., Inc.

**Edge Protector.**
Truscon Steel Co.

**Electrical Wires & Cables.**
American Steel & Wire Co.

**Elevating Graders.**
Austin-Western Road Machinery Co.

**Elevators.**
C. H. & E. Mfg. Co.

**Engineering Instruments.**
Kolesch & Co.
Lufkin Rule Co., The

**Engines.**
C. H. & E. Mfg. Co.

**Excavating Machinery.**
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

**Expansion Joint Compound.**
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

**Explosives.**
E. I. du Pont de Nemours & Co.

**Fence, Iron.**
Cincinnati Iron Fence Co.

**Fillers (Paving Joint).**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

**Fire Brick.**
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

**Flue Liners.**
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

**Forms, Sidewalks, Curb & Gutter.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Forms, Road.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Forms (Sewers & Conduits).**
Heltzel Steel Form & Iron Co.

**Forms (Wall Bldg., Construction, Etc.).**
Heltzel Steel Form & Iron Co.

**Gas Pipe.**
U. S. Cast Iron Pipe & Fdy. Co.

**Graders.**
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

**Granite Block.**
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

**Gravel Screener and Loader.**
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

**Heaters (Rock and Sand).**
Littleford Bros.

**Heating Plants, Central.**
American District Steam Co.

**Heating Wagons (Oil and Tar).**
Good Roads Machinery Co., Inc.
Littleford Bros.

**Hoists (Concrete, Gasoline and Hand).**
Pawling & Harnischfeger.

**Hoists, Electric.**
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

**Hoists, Steam.**
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

**Hot Mixers.**
F. C. Austin Machinery Co.

**Hydrants.**
The Flower Company.

**Incinerators.**
William F. Morse.

**Inlets (Sewer).**
Dee Co., Wm. E.
Madison Foundry Co.

**Insulating Material.**
The Barrett Co.
Pioneer Asphalt Co.

**Joint Fillers (Paving).**
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

**Kettles (Portable).**
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

**Loaders.**
Brown Portable Conveying Machinery Co.

**Manhole Covers.**
Madison Foundry Co.
Dee Co., Wm. E.

**Mastic.**
The Barrett Co.
Pioneer Asphalt Co.

**Meter Boxes.**
McNutt Meter Box Co.

**Mixers, Asphalt.**
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

**Mixers, Concrete.**
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

**Mixers—Mortar.**
C. H. & E. Mfg. Co.

**Molds (Pipe & Culvert).**
Heltzel Steel Form & Iron Co.

**Motor Fire Apparatus.**
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Motor Trucks.**
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Motor Truck Flushers, Sprinklers and Oilers.**
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

**Municipal Castings.**
Dee Co., Wm. E.
Madison Foundry.

**Packing.**
Pioneer Asphalt Co.

**Paints (Asphalt).**
Barrett Co., The
Pioneer Asphalt Co.

**Paving Blocks (Creosoted).**
The Barrett Co.
Republic Creosoting Co.

**Paving Brick.**
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

**Paving Contractors.**
Warren Bros. Co.

**Paving Joint Compound.**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

**Paving Joint Filler.**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

**Paving Machines.**
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

**Paving Plants (Asphalt).**
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

**Pipe Cutters.**
W. W. Stickler & Bros.

**Pipe Dip and Coatings.**
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

**Pipe Manufacturers.**
U. S. Cast Iron Pipe & Fdy. Co.

**Pitch Filler.**
The Barrett Co.
Warren Bros. Co.

**Plows (Rooter and Wing).**
Austin-Western Road Mach. Co.

**Portable Paving Plants.**
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

**Portable Stone Bins.**
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

**Powder (Blasting).**
E. I. du Pont de Nemours & Co., Inc.

**Fla., Miami**—Plans prepared for storm and san. sewers in Westmoreland Sec.; also 12th Ave. Dist. Est. cost $150,000. C. W. Murray, Dir. Pub. Wks.

**Mich., Battle Creek**—City plans voting on $500,000 bonds for sewage disposal plant. Engineer not selected.

**Mich., Muskegon Heights**—Plans and profiles for Sanford St. storm sewer, Muskegon Heights, as drawn by City Engr. Gamble, passed by Council and will be submitted to State San. Engr. Edw. D. Rich. Plans provide for 15-in. sewer from McKinney Ave. to pt. 53$ ft. no. of main street and 12-in. sewer from that pt. no. to Sherman Blvd. Starting at Sherman Blvd. size of sewer will be as follows: 20-in. to Nume Ave., 18-in. to Barney Ave., 15-in. to Delano Ave. Plans call also for installation of 13 manholes and 41 inlets.

**Ohio, Akron**—W. F. Peters, Director Pub. Service plans to issue $700,000 bonds for vit. clay and segmental blk. sewers, etc. to prevent pollution of Pigeon Crk. J. E. Root, Delaware Bldg., Engr.

**Ohio, Barberton**—Director of Pub. Service will take bids in Feb., for 74,000 ft. vit. clay and segmental blk sewers in various streets in E. Barberton. Est. cost $225,000. H. W. Alcorn, City Hall, Engr.

**Ohio, Toledo**—Resolution passed authorizing issuance of $700,000 bonds for constr. of second unit of intercepting sewer system.

**Pa., Berwick**—City plans new sewers, $80,000. Alexander Potter, 50 Church St., New York, Cons. Engrs.

**Pa., Erie**—City will take bids about April 1st for completing intercepting sewerage sys. Est. cost $668,000. F. G. Lynch, City Engr.

**Tex., Beaumont**—T. Bartlett, Engineer, Calcasieu Bldg. San Antonio, Tex., making prelim. survey for City work to include san. and storm sewers, docks, paving plant, etc. Est. cost of impvts. about $1,500,000.

**Wash., Seattle**—Among the impvts. to cost $5,000,000 for year 1923 is the largest sewer job ever put over as a single impvt. here. 10 miles of sewers will be installed along 30th Ave. southwest and along slope of W. Seattle peninsula from Calif. Ave. to Youngstown. Cost of this proj. not estimated.

**Wis., Madison**—Constr. of sewage disp. plant has been recommended by Special Sewerage Comn. 5,000,000 gal. daily capy. plant. Nine Springs Marsh, southeast of Madison; Imhoff tank sys. with 5,000,- City Engr. H. C. Buser, City Clk. Est. cost $841,000.

## WATER SUPPLY AND PURIFICATION.

**Ariz., Safford**—Prelim. plans being prepared for supply mains, reservoir and distributing system, including 20 miles wood, cast iron and steel pipe. Est. cost $150,000. L. C. Kelsey, Nogales, Engr.

**Cal., Palo Alto**—Election may be held here to vote on $110,000 bonds for extens. to water works system. J. F. Byxbee, Jr., City Engr.

**Cal., San Diego**—Plans being prepared for extension of water mains, $300,000; construction standpipe, $85,000. Election probably March 20 to vote on bonds for above projects. F. A. Rhodes, City Engr.

**Ont., Lansing**—North York Twp. having plans prepared for water works sys. including pumps, pumphouse, cast iron mains, hydrants, valves, reservoir and tank. $125,000. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

**Ont., No. York Twp.**—Ratepayers passed by-laws authorizing expendt. of $125,000 on water works.

**Ont., Toronto**—City plans exten. to filtr. plant at Toronto Island, increasing capy. by 20,000,000 gals. per day, including mech. rapid sand filters, slow sand filters, and drifting sand filters. Est. cost $300,000; also plans 7,500 lin. ft. 6-in. mains in Orchard View Blvd., Edith and Belsize Drives, Glengarry Ave., Greer, Manor, and Tilson Roads. $25,000. R. C. Harris, City Engr.

**Ont., Wallingford**—City considering extension of water system. Est. cost of impvt. $150,000. Engineer not announced. For detailed information address Bd. of Selectmen.

**Ont., Windsor**—Essex Border Utilities Commission considering constr. of filtration plant. $760,000 bonds have been voted. W. Walker, 300 Ouellette Ave., Engrs.

**Colo., Grand Junction**—City will advertise for bids in Feb., for new rein. conc. reservoir, 15,000,000 gal. capy. $190,000 bonds voted. Burns & McDonnell, Interstate Bldg., Kansas City, Engrs.

**Conn., Wallingford**—City considering extension of water system at $150,000.

**Fla., Tampa**—N. S. Hill, Jr., Engr., 112 E. 19th St., New York City, has submitted report to City for water works system to bring water into Tampa from best source; sources under consideration being 8-21 miles from City; extension of mains in City; pumpg. equip., etc. Election will be called to vote on $1,272,000 bonds for project.

**Fla., Miami**—City will vote on $2,575,000 bonds for following impvts.: Water supply, $750,000, city hosp. addn. $100,000; incinerator unit, $35,000; san. sewers, $100,000; storm sewers, $75,000, etc., etc.

**Ill., Litchfield**—City planning artificial water basin of 300,000,000 gal. capy. Est. cost $165,000.

**La., Rayne**—Acadia Parish has voted $125,000 bonds for water and light extensions. J. B. McCrary & Co., 3rd National Bank Bldg., Atlanta, Ga., Cons. Engrs.

**La., Shreveport**—City will probably vote on $800,000 bond issue to cons. water wks. sys.; present plans include erec. of dam to cost approx. $100,000 at outlet of Cross Lake near Gas Center, and constr. of 30-in. main which would carry water by gravity flow to storage basins at City water works plant.

**Md., Baltimore**—Water Comn. of Public Impvt. Comn., has plans for constr. of $2,000,000 filtr. plant on Hillen Rd., opposite present filter plant at Montebello to have capy. of 128,000,000 gals. water daily with facilities for treating and purifying 110,000,000 gals. daily.

**Mich., Jackson**—City contemplates constr. new pumping sta., $150,000. Engineer not selected.

**Minn., Stewart**—Town will be in market about April 2nd for 65,000 gal. steel water tank. Emil Leistico, City Clk.

**N. Y., Niagara Falls**—City plans to lay mains at cost of $100,000. D. J. Fort, 251 Second St., City Engr.

**O., Martins Ferry**—Plans being prepared for pumping station, two 4,000,000 gal. pumps, ash-handling facilities, boiler plant and elec. generating sta. Est. cost $450,000. J. N. Chester Eng. Co. Union Bldg., Pittsburgh, Pa., Engrs.

**Pa., Johnstown**—Johnstown Water Co. intends constructing 600,000,000 gal. capy. reservoir on north fork of Bens Creek. $100,000. G. W. Sullivan, Locust and Market Sts., Engr.

**S. Dak., Aberdeen**—Water works impvts. planned, including 500,000 gal. rein. conc. reservoir, 125 ft. elev. tank, 200,000 gal. capy., laying 12 miles main in So. Main St., pumphouse. $150,000. F. LeCocq, City Engineer.

**Tex., Amarillo**—Wynkoop Kiersted, Cons. Engrs., Interstate Bldg., Kansas City, Mo., submitted report recommending water works impvts., including adequate water supply, reservoir, ground walls, etc. $921,000 exclusive of dam site and right-of-way for proposed 24-in. gravity conc. pipe line. L. D. Marrs, Mayor.

**Tex., Austin**—Election soon to vote on $500,000 bonds for new filtration plant, extension of mains and laterals. Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., Engrs.

**Tex., Fort Worth**—$2,750,000 bonds voted. $1,500,000 for water and sewers; streets, $800,000; lights, $250,000; fire and police dept., $200,000.

**Tex., Highland Park**—$125,000 voted by City for water impvts., here. Henry R. Davis, Mayor.

**Va., Newport News**—War. Dept. reported to expend about $150,000 in impvts. to water plant at Big Bethel. Plans include repairs to reservoir, enlargement of dam, piping at Langley Field, erect. of 250,000 gal. steel tank at Fortress Monroe and installation of 11,000 ft. water main.

**Wash., Everett**—Approx. $65,000 will be expended by Water Dept., in pipe and other material and construction if a secondary service main is installed parallel with present main which provides an outlet for water in city reservoir located on heights of Fairview.

**Wis., Racine**—Plans being prepared for new water wks. intake, 7,000 ft. 36-in. cast iron pipe, crib and intake well. $280,000. Alvord, Burdick & Howson, 8 S. Dearborn St., Chicago, Engrs.

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**Pumps.**
De Laval Steam Turbine Co.
Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

**Reinforcing For Pavements.**
American Steel and Wire Co.
Truscon Steel Co.

**Road Building Material.**
Kentucky Rock Asphalt Co.
The Texas Co.

**Road Binder.**
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

**Road Forms.**
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

**Road Graders.**
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

**Road Machinery.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

**Road Planer.**
Austin-Western Road Machinery Co., The

**Road Oil and Preservatives.**
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

**Road Rollers.**
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

**Rock Crushers.**
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

**Roofing Material.**
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

**Sand Dryers.**
Cummer & Son Co., The F. D.
Littleford Brothers.

**Saw Rigs.**
C. H. & E. Mfg. Co.

**Scarifiers.**
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

**Scrapers, Drag Line.**
Pawling & Harnischfeger.
Sauerman Bros.

**Scrapers, Graders, Plows, Etc.**
Austin-Western Road Machinery Co., The

**Scrapers, Power.**
Sauerman Bros.

**Sewage Treatment.**
Direct Oxidation Process Corp.

**Sewer Braces.**
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

**Sewer Cleaning Machinery.**
Stewart, W. H.

**Sewer Forms.**
Heltzel Steel Form & Iron Co.

**Sewer Pipe.**
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

**Sewer Pipe Joint Compound**
The Barrett Co.

**Sewer Rods.**
Stewart, W. H.

**Slide Rules.**
Kolesch & Co.

**Sluice Gates.**
Coldwell-Wilcox Co.

**Snow Removal Machinery.**
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

**Soaps—Liquid.**
Integrity Chemical Co.

**Special Castings.**
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

**Sprinklers.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

**Steel Joists, Studs and Sash.**
Truscon Steel Co.

**Steel Tapes.**
Kolesch & Co.
Lufkin Rule Co., The

**Stone Crushers.**
Austin-Western Road Machinery Co., The

**Stone Elevators.**
Austin-Western Road Machinery Co., The

**Stone Spreaders.**
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

**Stone Screens.**
Austin-Western Road Machinery Co., The
Littleford Bros.

**Street Cleaning Machinery (Horse Drawn).**
Austin-Western Road Machinery Co., The

**Street Paving Material.**
The Texas Co.

**Street Sprinklers (Horse Drawn).**
Austin-Western Road Machinery Co., The

**Structural Steel.**
Lewis-Hall Iron Works.

**Subgrading Machines**
Austin Machinery Corp.
The Hug Co.

**Surveyors' Instruments.**
Kolesch & Co.
Lufkin Rule Co., The

**Sweepers.**
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

**Tamping Machines.**
Pawling & Harnischfeger.

**Tanks, Water Supply.**
Littleford Brothers.

**Tar and Pitch**
The Barrett Co.

**Tar Heaters.**
Littleford Brothers.

**Tarvia.**
The Barrett Co.

**Testing Chemists.**
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

**Traction Engines (Oil or Kerosene).**
Austin-Western Road Mach. Co.

**Tractors.**
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

**Traffic Signals.**
Electrical & Specialty Supply Co.
Little Giant Co.

**Trailers.**
Lee Trailer and Body Co.

**Trench Braces.**
Kalamazoo Fdry. & Mach. Co.

**Trench Machinery.**
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

**Turbines, Steam.**
De Laval Steam Turbine Co.

**Turntables, Truck**
The Hug Co.

**Valves.**
Coldwell-Wilcox Co.
The Flower Company.

**Wall Coping.**
Cannelton Sewer Pipe Co.

**Warrenite.**
Warren Bros. Co.

**Water Main Cleaning.**
National Water Main Cleaning Co.

**Water Pipe.**
U. S. Cast Iron Pipe & Foundry Co.

**Waterproofing.**
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

**Water Purification.**
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

**Water Softener.**
The Refinite Co.

**Water Works Supplies and Equipment.**
Coldwell-Wilcox Co.
The Flower Company.
Pennsylvania Salt Mfg. Co.

**Wheeled Scrapers.**
Austin-Western Road Machinery Co.

**Wire Rope.**
American Steel & Wire Co.

**Windows (Steel).**
Truscon Steel Co.

**Wire-Cut Lug Brick.**
Murphysboro Paving Brick Co.
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# Those Wonderful California Roads

When the "native sons" switch from climate, they talk about roads—and foremost among the best roads in practically every county in California you will find

# Warrenite-Bitulithic Pavement

Endorsed by engineers, officials and citizens everywhere, it is the ideal road material where sturdy body and smooth, shock-absorbing surface are desired. Tested materials, laid under expert supervision and backed by thorough laboratory service, insure long life and low annual upkeep costs.

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# Highway Construction Equipment Service

If in the market for any of the following highway construction equipment, so indicate by check marks, mail this page to ***Municipal and County Engineering,*** 702 Wulsin Building, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

—Air Compressors
—Asphalt Plant, Portable
—Asphalt Plant, Railroad
—Asphalt Tools
—Asphalt Tool Wagon
—Bar Cutters and Benders
—Bars, Reinforcing
—Bins, Portable Stone
—Bodies, Dump Truck
—Brick Rattlers
—Catch Basin Covers
—Cement Testing Machinery
—Clam Shell Buckets
—Contraction Joint
—Cranes, Locomotive
—Crushers, Stone
—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
—Dump Wagons
—Excavator, Crane
—Elevating Graders
—Gasoline Locomotives
—Gravel Screener
—Heaters, Asphalt
—Heaters, Tar
—Hoisting Engines
—Industrial Cars
—Industrial Track
—Manhole Covers
—Mixers, Building
—Mixers, Hot
—Mixers, Paving
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—Motor Trucks (over 3 tons)
—Oil Distributors
—Portable Conveyor
—Portable Drilling Rigs
—Pile Drivers
—Pumps
—Reinforcing Steel
—Road Drags
—Road Forms
—Road Graders
—Road Mesh
—Road Planes
—Road Plows
—Road Rollers
—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
—Scrapers, Power
—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
—Surface Heaters
—Tampers, Road
—Tractors
—Trailers
—Turntables
—Unloaders, Car
—Wagon Loader
—Wheeled Scrapers
—Wire Mesh

# With Jaws and Hammers of Steel

**Into a steel-lined pit, like a huge inverted bell with upright clapper, crash six tons of limestone and shale from a dump car.**

**The long process of crushing and grinding necessary in cement making begins.**

Slowly, steadily, the great clapper of the gyratory crusher travels a circular path—crunches the huge chunks of stone to inch-and-a-half fragments.

The fragments pour out below on their way to the grinding mills.

In the first mill, a hundred hinged hammers pound and crush the rock to particles the size of sand.

Next, the materials go to the tube mill—a cylinder as big as a locomotive boiler, half filled with steel balls. As it revolves, it lifts the charge of steel and rock and tumbles it down again and again. An hour of this yields a powder finer than flour.

All this is only part of the grinding required. The powder is burned to glass-hard clinker—and then the grinding process starts all over again.

A jaw crusher cracks the clinker; balls hammer it to the fineness of sand.

And again, for an hour, the mass tumbles about in another tube mill, grinding and rubbing together clinker, steel balls and gypsum. Then you have cement.

To meet standard specifications, 78 per cent of the finished cement must pass through a sieve having forty thousand holes per square inch, which is finer than the finest silk.

To obtain a ton of finished cement, a cement plant grinds to this fineness two tons of raw materials, including coal, and a ton of glass-hard clinker—three tons altogether to make one ton of portland cement.

Crushing, grinding and pulverizing are among the more than eighty operations in cement making.

## PORTLAND CEMENT ASSOCIATION

*A National Organization to Improve and Extend the Uses of Concrete*

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# *Water Works Equipment Service*

If in the market for any of the following water works equipment, so indicate by check marks, mail this page to ***Municipal and County Engineering,*** 702 Wulsin Building, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

—Air Compressors
—Air Lift Pumps
—Ash Handling Mach'y
—Backfillers
—Brass Goods
—Chimneys
—Chloride of Lime
—Chlorinators
—Coal Handling Machinery
—Concrete Hoisting Equipment
—Concrete Tanks
—Condensers
—Conduit Rods
—Cranes, Locomotive
—Cranes, Traveling
—Curb Boxes
—Curb Cocks
—Derricks, Pipe Laying
—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
—Engines, High Duty
—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
—Filter Equipment
—Gates, Sluice
—Gauges, Recording
—Gauges, Steam
—Gauges, Water
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—Leadite
—Lead Furnaces
—Lead Wool
—Leak Indicators
—Liquid Chlorine
—Lime
—Meter Boxes
—Meter Couplings
—Meter Testers
—Motor Trucks
—Motors, Electric
—Oil, Lubricating
—Pipe, Cast Iron
—Pipe Cutters
—Pipe, Lead-Lined
—Pipe, Steel
—Pipe, Wrought Iron
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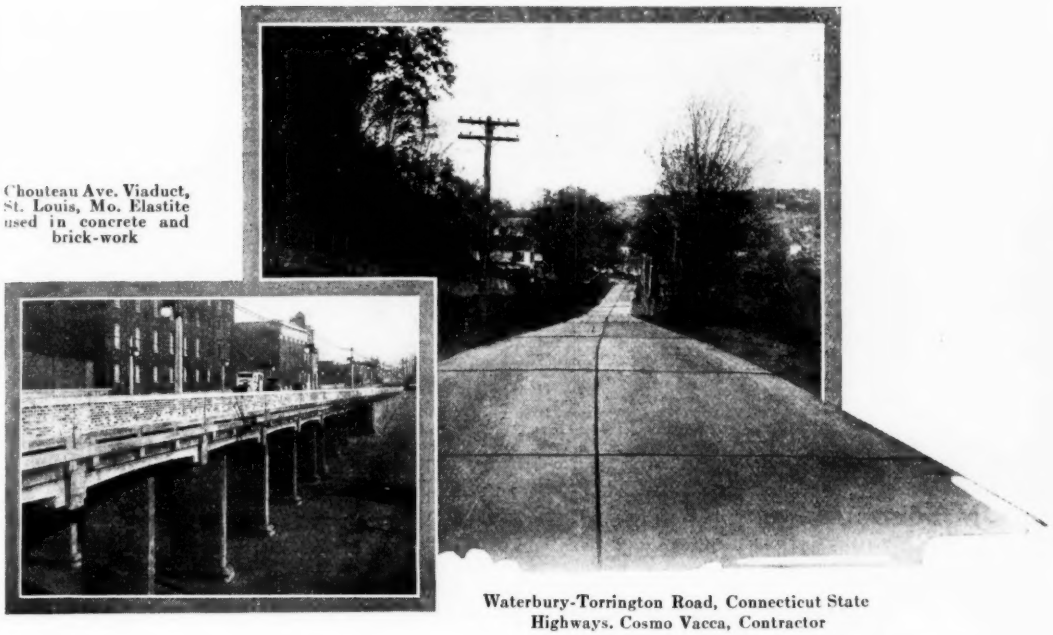
—Tapping Machines
—Trench Braces
—Trenching Machines
—Valve Boxes
—Valve Inserters
—Valves, Gates
—Valves, Pressure Regulating
—Water Main Cleaners
—Water Meters
—Water Softening Plants
—Welding Apparatus
—Well Drills
—Well Screens
—Well Strainers



Chouteau Ave. Viaduct, St. Louis, Mo. Elastite used in concrete and brick-work

Waterbury-Torrington Road, Connecticut State Highways. Cosmo Vacca, Contractor

# Protecting concrete against expansion

NO concrete road or concrete bridge should fail today because of expansion and contraction stresses. Temperature changes cannot affect the structure that is properly protected with Carey Elastite Expansion Joint.

Carey Elastite Expansion Joint is easy to install, and is durable as the concrete it protects; it absorbs all stresses of expansion; and it makes a permanent water-tight and frost-tight joint.

Miles of concrete roads, streets, sidewalks and bridges built in the last fifteen years owe their perfect surfaces and durability to Carey Elastite Expansion Joint.

There is enough Elastite Expansion Joint made by Carey each year to supply every construction job in the country. Seventeen cities have stocks ready for rush order shipments. You will want Carey Elastite Expansion Joint for your next job. Send for information and installation details *now*.

THE PHILIP CAREY COMPANY
40 Wayne Ave., Lockland, Cincinnati, Ohio

*Why Carey Elastite Expansion Joint does not stick together*

No talc is used in packing Carey Elastite Expansion Joint, yet it does not stick together. Its melting point is 250 degrees Fah., beyond any temperature likely to be encountered in storage, shipping, or use. Further, the felt walls give it stiffness without excess weight, making it easily handled, and also prevent any contact of the asphalt filler in any slab with that of another. It is handled like lumber, one man installs it in one operation, and a Carey Elastite Expansion Joint never needs replacing or repouring.

Carey Elastite
TRADE MARK REG. U.S. Pat. Office
EXPANSION JOINT
PROVED AND ACCEPTED

Carey Elastite Expansion Joint is an asphaltic body sandwiched between two walls of asphalt-saturated felt, making an elastic, compressible joint. Made in any dimensions, cut to crown or special shape, and comes to the job ready to use.

3-23

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## The Last Word in Culverts.

**Austin Corrugated Galvanized Culverts** (pure iron or copper steel base) are designed to meet every federal, state or municipal requirement.

Manufactured from full length, full weight, prime galvanized sheets in standard culvert lengths and diameters. Each section carefully riveted in the valley of every corrugation, and also where sections are joined together (double riveted on large diameter pipe). Connecting bands are of the same material as the sheets and are furnished with galvanized bolts, making it very easy to connect one or more sections in the field. Two full corrugations of material are allowed for the end reinforcement which is of the same material as the culvert and securely riveted in place.

Recognizing the supreme importance of a thorough protective coating agent, Austin Corrugated Galvanized Culverts carry a full two-ounce coating of virgin spelter for each square foot of exposed surface, which guarantees real, lasting service and satisfaction.

*A Special Circular tells the whole story of Austin Culverts. Write for one today.*

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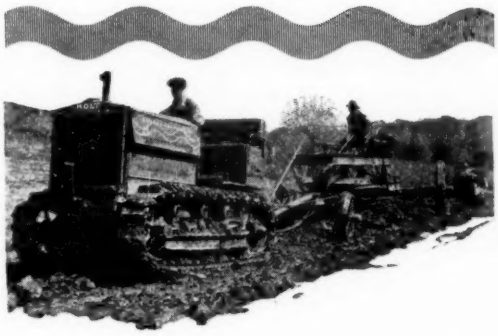
*"Everything from a Drag Scraper to a Road Roller"*





# Iowa, for example,

**Determined to put their primary and township dirt roads into usable condition and to keep them so the year round by constant patrol maintenance, numerous Iowa Counties have adopted "Caterpillar"* Tractors. Poweshiek and Muscatine Counties, each with six "Caterpillars,"* Johnson County with five, Iowa and Green Counties with four, Crawford with three, Cass with two, are but typical of the counties and townships in Iowa, as well as other states, which have standardized on "Caterpillars"* as the surest means of making road funds go furthest. Your community should be "Caterpillar"*-equipped, whether your good-roads program involves the maintenance of roads already built or the construction of new roads through the heavier operations of grading, scarifying and hauling material. Send for our booklet, "The Nation's Road Maker."**

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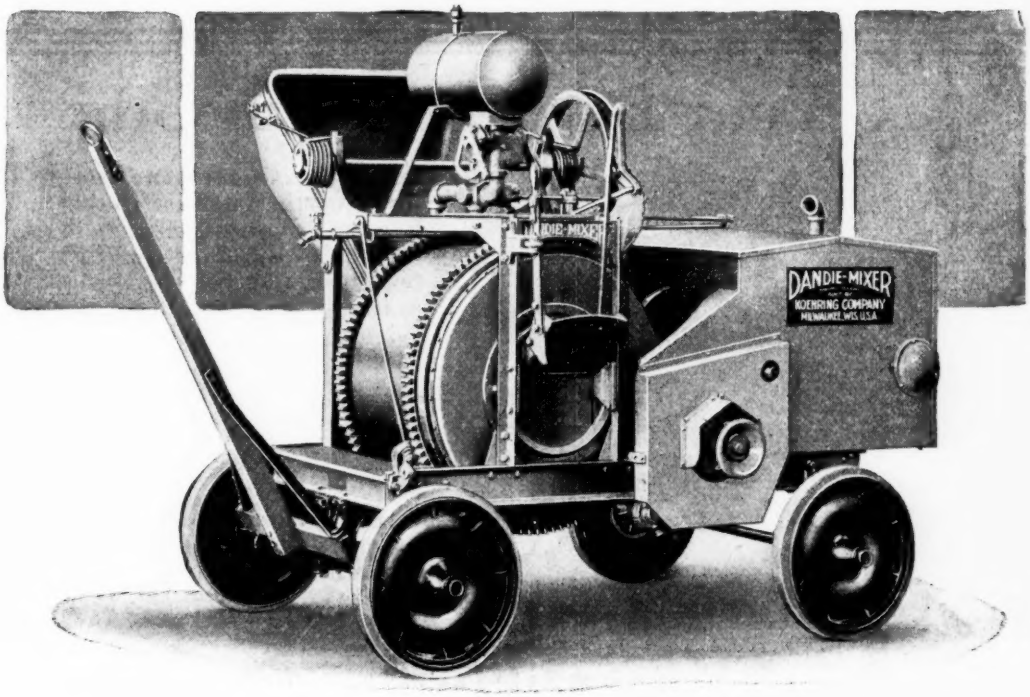
**There is but one "CATERPILLAR"—Holt builds it*

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SAVE time moving from job to job, and use the time for putting concrete in the forms. That's turning overhead into profits.

Hitch the rubber tired Dandie behind your truck and speed from job to job. That means more jobs done per season, and a bigger working field. Where could you find an easier, surer profit?

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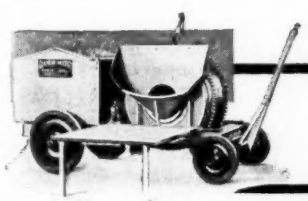
The Koehring Dandie light mixer is the remarkable value in the light mixer field—built light, but with best Koehring construction—yet selling within the price range for light mixers.

**Koehring Dandie Capacities**

4 and 7 cubic feet mixed concrete. Steam and Gasoline. Power charging skip or low charging platform—automatic water-measuring tank. Discharge control from both sides. May be equipped with light duty hoist. Mixes mortar as well as uniform concrete.

***Learn to judge mixer construction—send today for Koehring Dandie Catalog No. 10.***

KOEHRING COMPANY, MILWAUKEE, WIS.
MANUFACTURERS OF CONCRETE MIXERS AND CRANE EXCAVATORS



**KOEHRING DANDIE LIGHT MIXER**

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*The Andresen Road Repair Outfit*
*(Patented)*

**Smooth pavements not only serve better but last longer. Proper maintenance with proper equipment makes it possible to do this work successfully and economically.**

**THE ANDRESEN ROAD REPAIR OUTFIT**

**can be used for repairing any type of paving without the need of additional equipment.**

**Leading road officials everywhere have adopted it for efficient maintenance work.**

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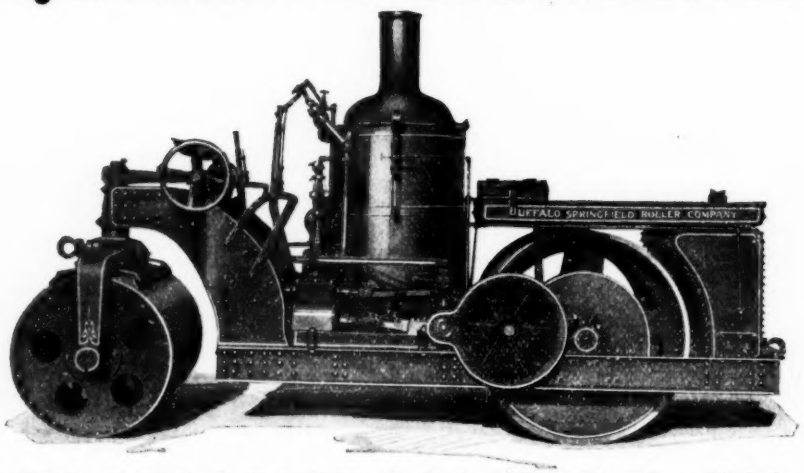
**430 E. Pearl St.** **LITTLEFORD BROS.** **Cincinnati, Ohio**

# QUALITY ROLLERS

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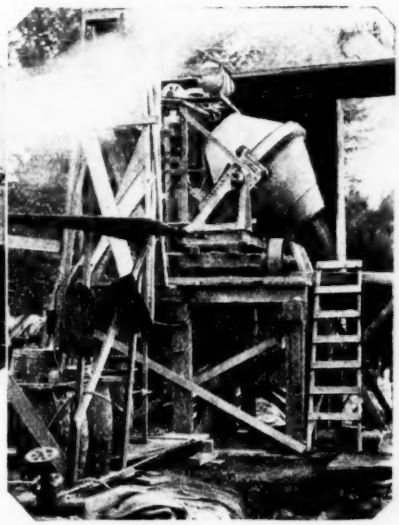

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The 4000 yards of reinforced concrete required for the new institution —530 ft. x 30 ft., with 80 ft. x 40 ft. wing, were poured in two months—the concrete being mixed by a Smith 10-S Tilting Type Mixer.

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The practically endless life of Smith Concrete Mixers, proven by a quarter of a century of satisfactory service, has convinced contractors that the design and construction are right.

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Several great States have so ruled.

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## Concrete Reinforcement

**Fulfills every engineering requirement.**

*Send for our booklet on road building.*

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"PIONEER" Highest Quality ASPHALTS

"PIONEER" Highest Quality ASPHALTS

# Filler Asphalt

The ideal brick pavement filler. Made to meet the strictest specifications. Low prices and immediate delivery on any quantity.

## "PIONEER"

Every monolithic pavement should have an Expansion Joint. **"Pioneer"** is made from an absolutely pure asphalt, giving maximum expansion and contraction efficiency.

## Expansion Joint

**THE PIONEER ASPHALT CO.**
LAWRENCEVILLE, ILL.

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## ARE WIDELY USED

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## STEWART SEWER CLEANING MACHINE

Water Cleaning System, if you wish it, or Drag Bucket type.

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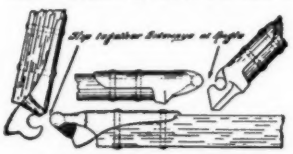

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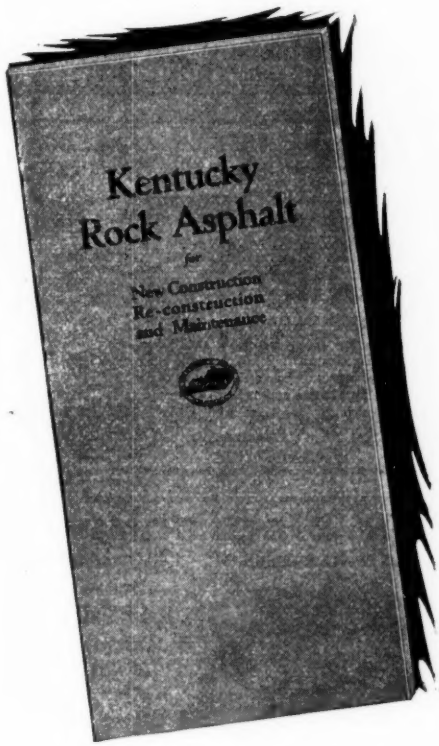
**PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO.**

# This Book Will Help Solve Your Paving Problems

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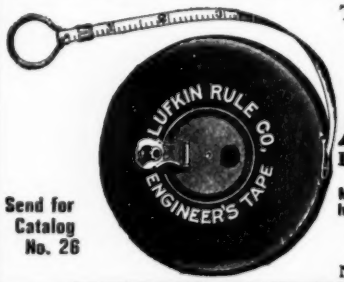


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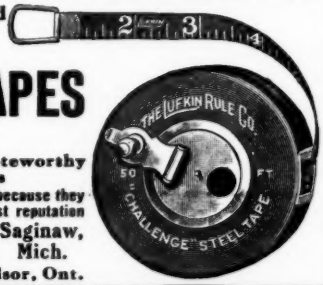


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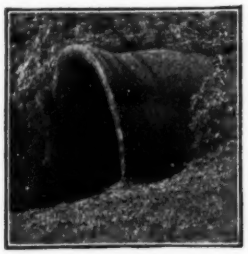

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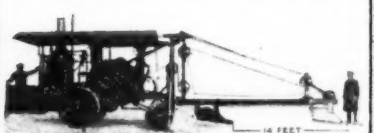


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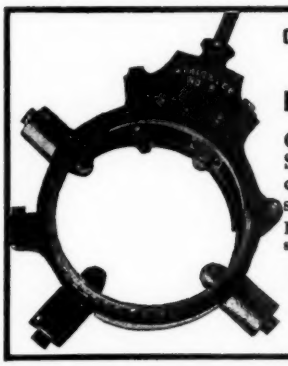

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